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SCIENCE

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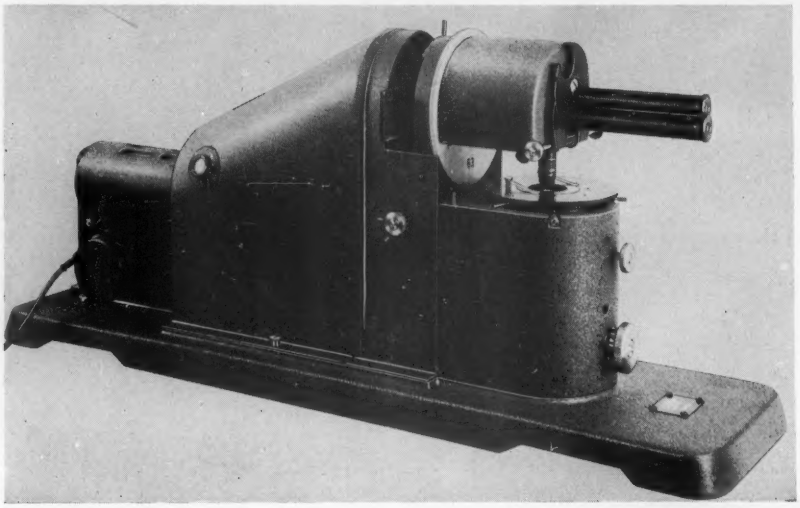

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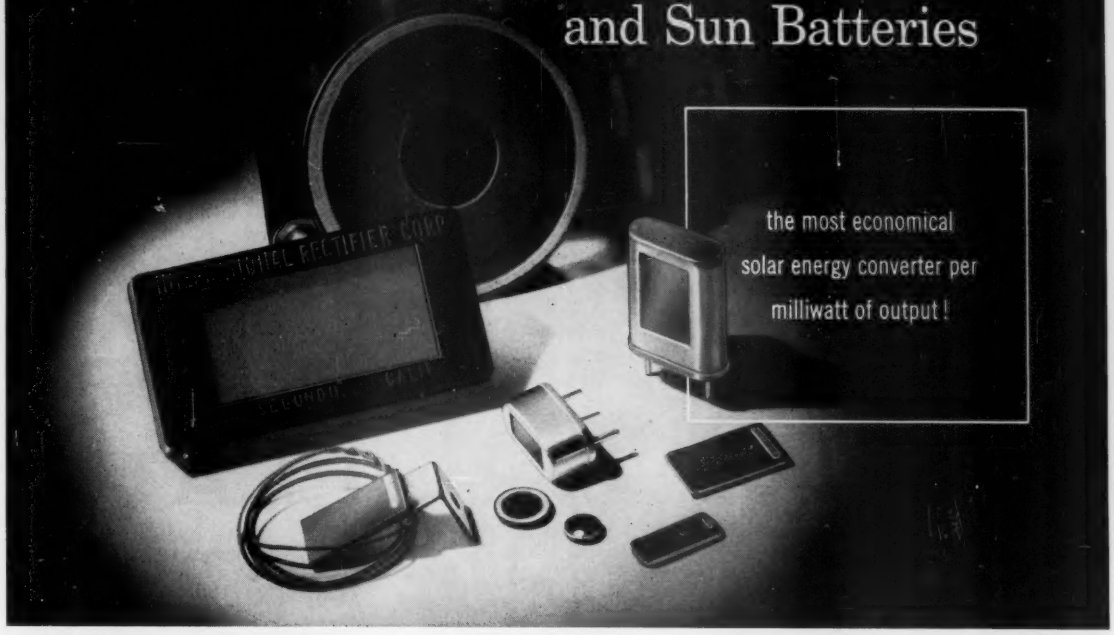

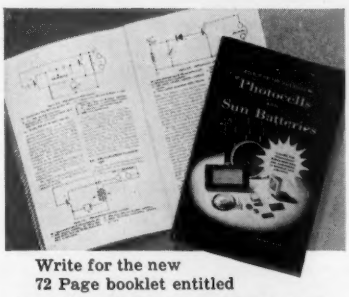

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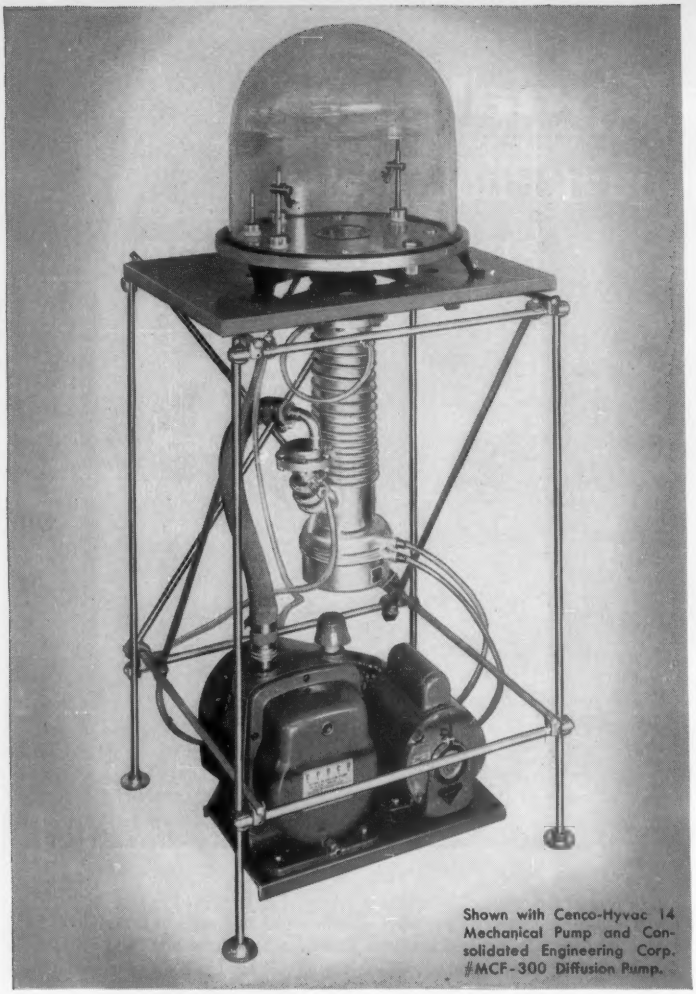

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John Bull's Other Universities

Many Americans believe that to get a university education in the United Kingdom you must go to Cambridge or Oxford and attend a residential college with a name spelled one way and pronounced another. Undoubtedly, Englishmen do go to these universities—and, undoubtedly, Englishmen enjoy their tea and crumpets—but Britain's educational resources, like the national diet, are more extensive than popular opinion in the United States has it.

A measure of this opinion may be found in the choices expressed by the candidates for a recent group of awards. The awards were the 12 Marshall scholarships for graduate study at British universities. The British government offers these scholarships each year to American citizens in recognition of the aid rendered under the Marshall plan. Subject to review in London, the British ambassador in Washington, with the assistance of an American advisory council, makes the final selection of scholars. Of the 471 candidates for 1956, more than half gave Oxford as their first or second choice, and more than half gave Cambridge similar preference.

The group charged with the selection of fellows believes that Americans should be better informed about the considerable strength of Britain's other universities. London University and the University of Edinburgh ranked third and fourth in the preferences of candidates, but little mention was made of Manchester, Leeds, Sheffield, Durham, Birmingham, or the rest of what the British call, in a special sense, their provincial universities.

Three British scholars have prepared papers for this issue of *Science* on scientific and engineering education in their country. The first paper tours the various institutions, noting which specialities are served at which faculties, and giving an account of the advantages in laboratory facilities and local industries that go with particular locations. The second paper is about the Royal Society of London, describing its history, the value of its traditions to the present fellows of the society, and the distribution of the fellowship among British universities. The third paper describes the working conditions of British graduate students. It considers the manner in which they are selected, their finances, the courses they take, the examinations they undergo, their research, and their possible future careers.

Of course, the British, in turn, have their views about American education. In *Cousins and Strangers*, published recently by Harvard University Press, may be found a selection of remarks by British students attending universities in this country under grants from the Commonwealth Fund. Commenting on the objectives and levels of attainment of American universities, the visiting fellows are sometimes critical and sometimes highly complimentary. Again, however, the tendency is to focus attention on only a few universities, and little mention is made of America's other educational resources.

Good intellectual relationships between our two countries require that information flow both ways. We hope the present issue of *Science* will, in part, meet the need for more information about British universities, and that scholars who visit the United Kingdom, either through international grants such as the Marshall scholarships, or through other means, will make more adequate use of the varied fare that country offers.—J.T.

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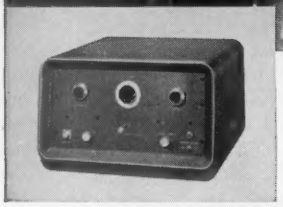

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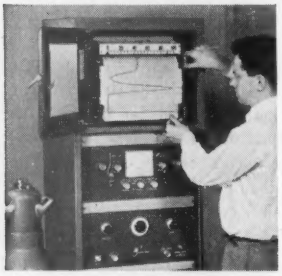

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Provincial Universities in the United Kingdom

Trevor I. Williams

When used in connection with British universities, the word *provincial* denotes all universities save the ancient foundations of Oxford and Cambridge; even London University, now well over a century old and with a firmly established reputation and traditions of its own, is "provincial" in this special academic sense. The provincial universities of the United Kingdom are of high standing, and indeed many of them can offer facilities not available at the older institutions. Particularly is this so in the case of many of the science faculties, which collectively offer great opportunities for the student.

Enlightened Policy

When all the provincial universities have so much to offer, it is difficult to decide which should have first mention. On any count, however, the University of Manchester must rank very high, and its enlightened policy of scientific training and research certainly justifies the city's traditional boast that what Manchester thinks today London thinks tomorrow. Certainly there is no sign here of provincialism in the sense of narrowness and lack of enterprise.

Manchester University is the oldest civic foundation in England, having been opened—originally as Owens College—in 1851. The faculty of science offers the student as extensive a range of subjects as is to be found anywhere, and apart from its degrees, the university offers diplomas in various special subjects such as bacteriology and chemical engineering. In addition there are a number of exceptional facilities.

Outside the city, at Jodrell Bank, the great 260-foot radio telescope, an instrument without parallel in the world, is nearing completion. It is impossible to say precisely what this remarkable instrument will achieve, for it will be used for the exploration of a new domain of science, but recent progress in radio astronomy made with less powerful instruments makes it clear that the prospects are exciting. It is clear that with its help a tremendous amount of new information about the remotest parts of the universe will be collected. For many years to come, Jodrell Bank will be an outstanding international center for radio astronomical research. At Barton airport is a well equipped laboratory for research on fluid motion. The university has also been for some years an important center for the development of electronic computing machines. It has an experimental horticultural station in Manchester and an out-station in Cheshire.

Also in Manchester, and closely associated with the university, is the College of Technology, which offers a choice of well over 200 courses. At any given time nearly one-tenth of its 8000 students are reading for university degrees or diplomas. Among the special courses of study available there are ones on textile chemistry, printing and photographic technology, and municipal engineering.

Ties with Local Industry

Manchester University is situated in the heart of a busy manufacturing area. It is typical of many similarly placed universities in that, apart from offering a full range of essentially academic courses, it has special courses reflecting local industrial interests, among which cotton is in this instance outstanding. Leeds, some 40 miles away, is comparable, but here a different textile, wool, is the center of interest. The departments of textile industries and of color chemistry and dyeing at Leeds have an international reputation. There is also a course in the chemistry of leather manufacture which is the only one of its kind in the United Kingdom. The technological faculty also offers courses in coal gas and fuel industries and mining. Mining students receive first-hand practical instruction under arrangements made with the National Coal Board.

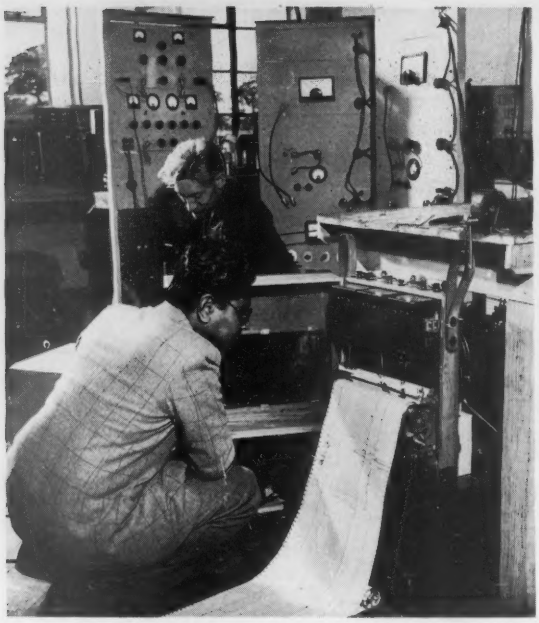
The very name of Sheffield is almost synonymous with steel, and it is therefore not surprising that in Sheffield University there is a strong metallurgical faculty. The department of glass technology was the first of its kind in the world and remains among the best known. Among other special facilities at Sheffield may be mentioned the laboratories for research on concrete and soil mechanics; these enable research to be carried out under conditions not usually obtainable in universities.

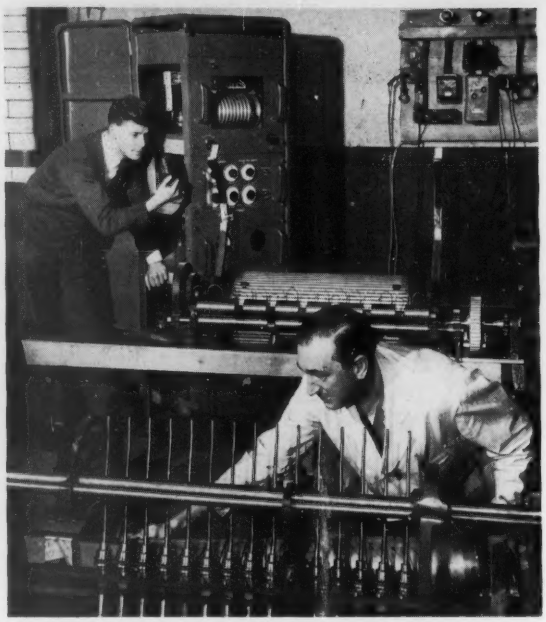
Durham University, too, has developed close ties with local industry. Newcastle-upon-Tyne, where King's College, one of the constituent colleges, is situated, is a famous shipbuilding center, and there departments of marine engineering and naval architecture have been established. Also at Newcastle is an extensive agricultural department with its own experimental farm. Since World War II a new and very well equipped chemistry block has been built.

To the south of Newcastle is Hull, on the Humber, whose university is next to the youngest in the the United Kingdom, having been incorporated as recently as 1954.

Also reflecting the industrial activity of its environment is the University of Liverpool, whose faculties include one of veterinary science. Liverpool is a famous center for all kinds of research on tropical diseases, arising primarily from the fact that to the busy port go ships from every part of the world; and there are special facilities for their study. These include a heated insectarium. The university maintains a marine biological re-

Dr. Williams is editor of *Endeavour* and chairman of the Association of British Science Writers.





(Left). M. K. Das Gujola and R. C. Jennison studying the recordings made from results coming through from the solar interferometer aerials at Manchester University's giant radio telescope. (Right). E. A. Mather (foreground), an instrument engineer, working on the electronically controlled spinning mule in the department of textile industries at Leeds University. The cabinet replaces the large and cumbersome headstock of the old-fashioned spinning mule. It was invented soon after World War II by N. H. Chamberlain and postgraduate research student B. E. King (left).

search station in the Isle of Man. The Liverpool Observatory and Tidal Institute is a unique center for research on tides and related geophysical subjects. The department of inorganic and physical chemistry is housed in a finely equipped laboratory opened only a short time ago, and it is well known for its work on polymer chemistry. The department of physics offers very exceptional facilities for atomic research. Its equipment includes a large, 156-inch cyclotron as well as a smaller 37-inch machine.

Active Research Centers

At Birmingham the faculty of science is divided into 14 separate schools and offers a wide range of courses, including such diverse subjects as industrial fermentation, chemical engineering, and metallurgy. The equipment of the physics department, which is a very active research center, includes a 60-inch cyclotron and a 1000-Mev synchrotron.

Further to the south, well away from the main industrial area, is the University of Bristol. Here again, a very wide range of general courses of study is offered, as well as some special facilities. The physics department is exceptionally well housed and equipped, and the work done on cosmic rays is internationally known. Internationally known, too, but in a very different sphere, is the agricultural research station at Long Ashton, just outside the city. Here extensive research is done on fruit growing. At Reading University, too, there are special facilities for studies in experimental farms and also the well known National Institute for Research in Dairying.

Further to the south still is the newly incorporated University of Southampton, which received its charter in 1952. The university is in fact, however, a much older foundation, for it evolved from the Hartley Institute, which was founded in 1852. It offers a full range of scientific studies. Southampton itself is an important center for aircraft construction, and this interest is reflected in the university. The engineering department, which has high- and low-speed wind tunnels and other special provisions for instruction in aeronautics, offers a special 4-year course in aeronautical engineering. Each year the student spends two terms at the university and 6 months with a local firm of aircraft manufacturers. At Warsash is a school of navigation which is affiliated with the university.

London University is the largest university in the United Kingdom. It has a special claim to fame as being the first university in England to admit students of all creeds, the first to admit women to all degrees and distinctions, and the first to found a faculty of science. Its development has, in the main, been precisely the opposite of that of both Oxford and Cambridge. While the residential colleges of the latter have grown out of the university, the University of London is primarily the result of the amalgamation of several nonresidential institutions.

The teaching organization of London University is too complex to discuss here in detail, but it falls under three headings. First, there are institutions belonging to and controlled by the university. Second, there are schools of the university, each controlled by its governing body—outstanding among them in the present context is the Imperial College of Science and Technology at South Kensington. Third, there are a number of other educational institutions whose teaching is recognized by the Senate of the university. These include East Malling Research Station and Rothamsted Experimental Station. Collectively, these bodies offer a remarkable variety of scientific training.

The Imperial College of Science, in South Kensington, exists "to give the highest specialized instruction and to provide the fullest equipment for the most advanced training and research in various branches of science, especially in its application to industry." It already has comprehensive facilities for technical training, offering courses in, for example, aeronautical engineering, chemical engi-

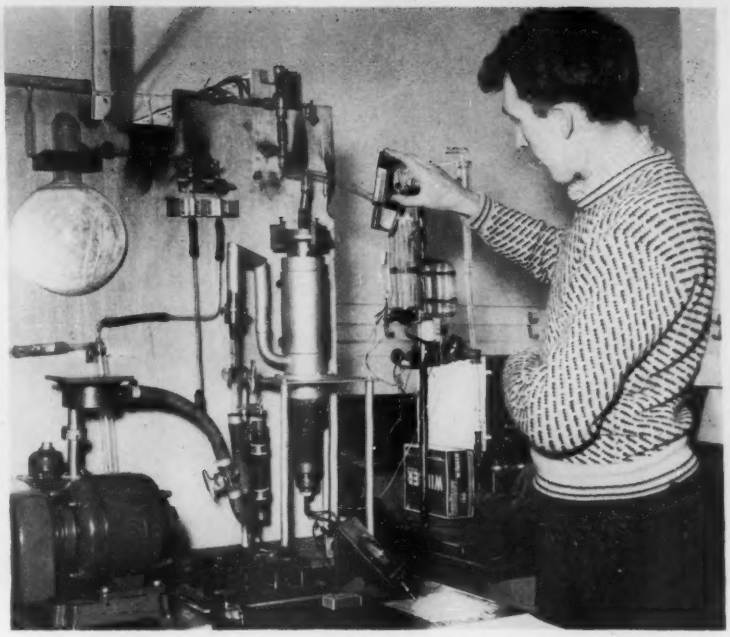
neering, botany, and geology; plans are being put in hand immediately to expand it greatly, at a cost of some £15 million ($42 million), and make it the foremost center for technological study in Great Britain. The expansion should be complete by 1962, by which time there will be provision for 3000 full-time students.

Facilities in Wales, Scotland, and Northern Ireland

Wales, Scotland, and Northern Ireland can all provide excellent facilities for advanced scientific education. The University of Wales, for example, can offer several special courses. Aberystwyth can provide facilities for training in dairying, agriculture, plant breeding, and animal science. Cardiff offers, in addition to a wide range of scientific degree courses, diplomas in engineering, metalliferous mining, metallurgy, and social science. Swansea includes departments for chemical engineering and metallurgy. Bangor has a marine biological station.

Scotland has a very firmly established tradition of sound education, and science was introduced into the curriculums at a relatively early date. All the Scottish universities are ancient foundations. St. Andrews University dates from 1410; today it offers a comprehensive course of training in science. Much of the technical and scientific training is provided at Queen's College, Dundee.

One of the constituent colleges of Aberdeen University traces its history back to 1494; the other original college was founded in 1593. This university has the distinction of having been the first in the United Kingdom to establish a faculty of medicine. The university itself offers a comprehensive training in all branches of science, and associated institutions give facilities for various kinds of special instruction. Thus the Macaulay Institute is well known for soil research, and the Rowett Institute is well known for research on animal nutrition.

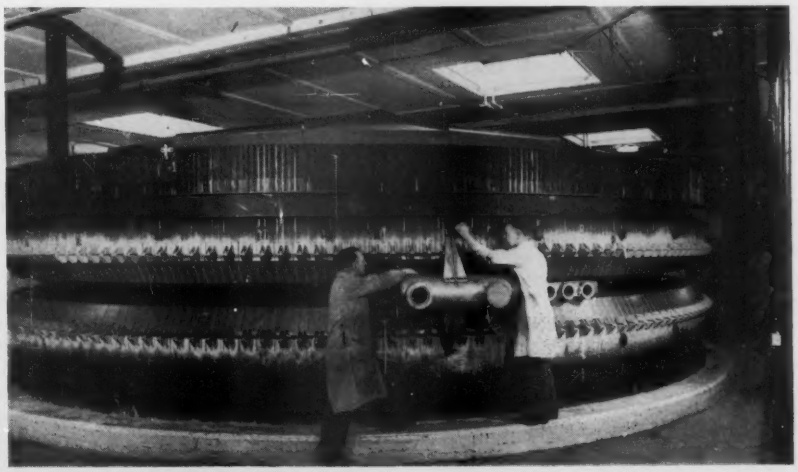


Physics student engaged in atomic research at Glasgow University.

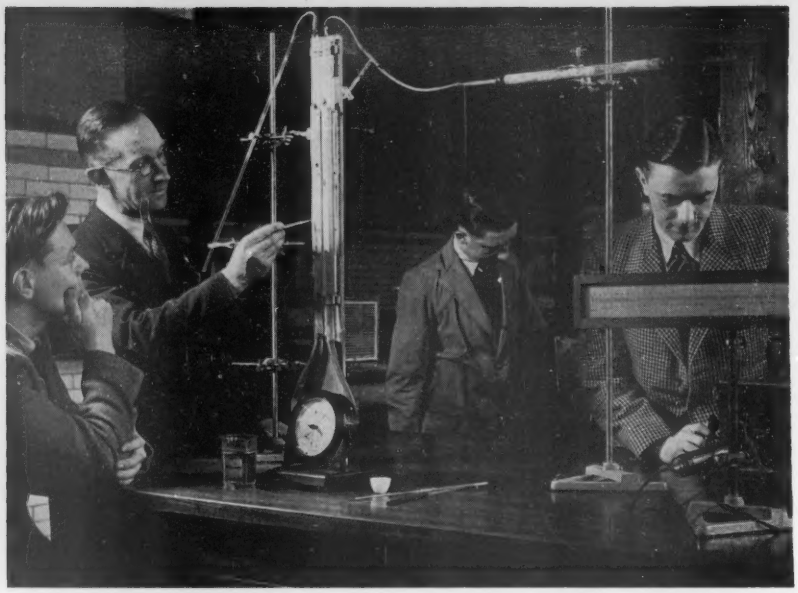
The University of Edinburgh is another very old foundation, dating from 1583, and particularly well known for its medical teaching, with which the teaching of science, and especially of chemistry, has long been associated. There are comprehensive degree courses in science as well as diploma courses in such special subjects as electronics and radio, animal genetics, forestry, and geophysical surveying. The Royal (Dick) School of Veterinary Studies was incorporated in the university in 1951.

Glasgow University, too, is a very old foundation, having been founded in 1451, and the teaching of science was firmly established there during the 18th century. It now offers a full degree course of instruction in all the major branches of science and engineering. Closely associated with the University is the Royal Technical College, at which certain of the degree courses are given.

By comparison with the Scottish universities, the Queen's University of Belfast is a modern foundation, having been founded in 1845, but it is nevertheless



Proton synchroton at Birmingham University. It was built by members of the physics department.



Lecturer demonstrating a viscometer to a group of students in the Herschel Laboratory of the physics department of Durham University.

quite old enough to have a firmly established tradition of science teaching. This is being much strengthened by the building of a new science block, to be completed in 1958, to house the departments of civil engineering, chemistry, botany, and zoology. At Hillsborough the university maintains an agricultural research institute.

Conclusion

This necessarily brief survey of the scientific facilities of the provincial universities in the United Kingdom cannot even mention many of their special features. But enough has been said, it is hoped, to indicate that they deserve the most careful attention of the intending student, whose requirements must be exacting indeed if he cannot find among them a course to suit his needs.

It is worth remarking, too, that the provincial universities can offer a great deal more than good technical facilities and competent teachers. For the student who stays long enough to complete a full course of study, they offer the opportunity of seeing sides of life in the United Kingdom which the visitor all too seldom appreciates. Like every other country, the United Kingdom is not homogeneous, and every region has its own characteristic features. Although the advent of rapid transport, and of media of mass entertainment, such as the radio, television, and films, is rapidly ironing out the local differences in the population which were so marked only 50 years ago, they still exist in sufficient degree to be very noticeable and interesting.

Some parts in which are situated such universities as those of Manchester, Sheffield, Leeds, Liverpool, and Glasgow are heavily industrialized and thus have innumerable features of interest for the student of applied science. At the same time, all have fairly close at hand attractive country whose exploration can provide pleasant occupation for leisure hours.

Fellowship of the Royal Society

D. C. Martin

"Gentlemen, . . . I trust that in all our researches we shall be guided by that spirit of philosophy, awakened by our great masters, Bacon and Newton; that sober and cautious method of inductive reasoning which is the germ of truth and of permanency in all the sciences. I trust that those amongst us who are so fortunate as to kindle the light of new discoveries will use them not for the purpose of dazzling the organs of our intellectual vision but rather to enlighten us, by showing objects in their true form and colors; that our philosophers will attach no importance to hypotheses except as leading to the research after facts so as to be able to discard or adopt them at pleasure treating them rather as parts of the scaffolding of the building of science, than as belonging either to its foundations, materials, or ornaments; that they will look, where it be possible, to practical applications in science, not however, forgetting the dignity of their pursuit, the noblest end of which is, to exalt the powers of the human mind, and to increase the sphere of intellectual enjoyment, by enlarging our views of nature and of the power, wisdom, and goodness of the Author of nature."

These words were addressed to fellows of the Royal Society in 1820 by Humphry Davy. The society was in the

Dr. Martin has been assistant secretary of the Royal Society since 1947.

160th year of its existence, and the distinguished chemist Humphry Davy was its 22nd president. He was restating the objects of the founder fellows of the Royal Society. These objects remain the objects of the Royal Society at the present time.

Founding

In the early part of the 17th century, the philosophic writings of Francis Bacon (1561–1626) greatly affected the minds of intellectual leaders in Europe. Bacon was an advocate of the experimental method of research, and he protested strongly against the deductive method which had been accepted until that time. He described his thoughts in a book called *New Atlantis,* and he believed that the fruits of the experimental method could best be achieved by the corporate action of men devoting their whole time to experimental investigations. This book had a great impact, and there can be little doubt that it opened up the way for the formation of the Royal Society and other academies of science throughout Europe. There was a campaigning enthusiasm among certain groups of men of quality in London to try out this new philosophy, and in the year 1645 these men began to have meetings to discuss the new philosophy and how they might set up a college of the type described by Bacon. This group of people, who were philosophers without a college building, came to be known as the invisible or philosophical college. Men whose names are now part of the fabric of science were in this group—for example, Robert Boyle and Christopher Wren. Some of their meetings were held in Gresham College in the City of London.

However, there was civil war in England at that time, and the holding of meetings became very difficult. Some of the philosophers went to Oxford and met there. Others remained in London, but the uncertainty of the times hindered the furtherance of any proposal to create a college of the type dreamed of by Francis Bacon, and it was not until the restoration of the monarchy in 1660 that the philosophers were again able to meet weekly. On 28 November 1660 they decided to give themselves a more formal constitution. In their memorandum of foundation, they agreed to continue their weekly meeting "on Wednesday, at 3 of the clock in the tearme time at Mr Rooke's chamber at Gresham College; in the vacation, at Mr Bull's Chamber in the Temple." There was an entrance fee of 10 shillings and a weekly subscription of 1 shilling. It is further recorded in this memorandum, which is still treasured in the society's archives as page 1, volume 1 of the Journal Books of the Royal Society, as follows.

Isaac Newton.

"And to the end that they might the better be enabled to make a conjecture of how many the elected number of this Society should consist, therefore it was desired that a list might be taken of the names of such persons as were known to those present, whom they judged willing and fit to joyne with them in their designe, who if they should desire it, might be admitted before any other."

Here then was the formation of this private society of natural philosophers. On that November day nearly 300 years ago, a dozen or so far-seeing men formally founded a society whose influence on the course of history has been considerable. The historian, H. A. L. Fisher, has written of this event as follows.

"The seventeenth century, which opens with the glowing dreams of Francis Bacon, closes with Isaac Newton's precise demonstration that the whole universe is one vast mechanism. Between these two names lies a long and splendid chapter of English scientific work, beginning with Harvey's discovery of the circulation of the blood in 1624 (reached only because he tested all his theories by experiment), carried on by Robert Boyle's epoch-making work in chemical science, illustrated by the foundation of the Royal Society and giving to England a place in the intellectual life of Europe, which the insular reputation of a Shakespeare or a Milton could not have secured."

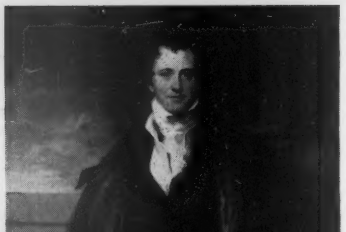
One of the leaders in the formal foundation of the society was Robert Moray, a courtier of King Charles II. He had accompanied Charles into exile, and a week after the memorandum of foundation was drawn up, Robert Moray is on record as having acquainted His Majesty with the "designe of this Meeting" (on 28 November). "And he did well approve of it and would be ready to give encouragement to it." Charles II, who himself was greatly interested in natural philosophy, kept his word and encouraged the newly born society, which soon began to be known as The Royal Society. He granted his royal charter on 15 July 1662, and in it the society was named "The Royal Society of London for Improving Natural Knowledge." A second charter was granted on 22 April 1663, and this one has largely governed the growth and development of the society. A third charter was granted in 1669, but this was relatively unimportant compared with the second charter. It is a striking tribute to the foresight of the founders that the second charter laid down principles and rules which remain unchanged today in governing the society's affairs. For instance, that charter lays down the composition of the council, insuring a constant flow of new fellows into the government of the society, and it has proved to be a system so admirably suited to improving natural knowledge that no attempt has been made to alter it.

Charles II gave further encouragement to the society by two fine gifts. On 23 May 1663, he gave the society a mace "of the same portion and bigness as those carried before His Majesty to be borne before our President on meeting days." A few months later, in January, he presented to the society a folio volume prepared in leaves of finest vellum and bound in crimson velvet; in it were inscribed the charter and statutes of the society. He signed this, describing himself "founder." It is my proud duty to carry this self-same mace before the president at each of our weekly meetings today, and likewise to assist at the inscription of this self-same Charter Book by each new fellow admitted to the society. Through these two cherished possessions, we have a tangible link with the worthy founders of this Royal Society. The monarch continues to be its patron, and the Charter Book contains, alongside those of the scientists, the signatures of all the royal patrons since Charles II. The signature of Queen Elizabeth graces the latest, specially illumined, royal page.

Members

I wish to draw attention particularly to the phrase "the names of such persons . . . whom they [the founder fellows] judged willing and fit to joyne with them in their designe, who . . . might be admitted [to the society] before any other." Like almost all the laws that govern the society today, the principles of election laid down in 1660 are still prescribed by the founder fellows.

That the founders judged well of those "fit to joyne them" is evident by the achievements of the early fellows. They were true amateurs or lovers of the new experimental method. Robert Hooke was



Humphry Davy.

one such, and he became the society's first curator. It was his duty each week to arrange the experiments which were to be discussed. This remarkable man, who gave his name to Hooke's law, did much to establish the society's early reputation. Likewise Henry Oldenburg, one of the first secretaries, who founded the *Philosophical Transactions* in 1665 and corresponded with men of science in other countries, made the society well known both in England and elsewhere. It was in 1671 that a young man of 29, destined to ornament natural philosophy in a manner unexcelled by anyone since, was admitted to the society. His name was Isaac Newton. He was president from 1703 to 1727, and by his illustrious works he brought the society the greatest renown. The society published Newton's *Principia*, and the society's clerk (or assistant secretary) of that day, Edmond Halley, did much to bring about the issue of this work, which was described by Laplace as "preeminent above any other production of human genius." Halley, himself a great astronomer, meteorologist, and geophysicist, was born in 1656, and in this tercentenary year of his birth the society was pleased to commemorate the event by naming the location of the society's International Geophysical Year base in the antarctic as Halley Bay.

It is not possible even to list the names of the great men of science who, since Newton's day, have brought distinction to the Royal Society. Benjamin Franklin was elected in 1756, and special mention must be made of Joseph Banks, who occupied the presidential chair for 42 years, from 1778 until 1820. He was a keen and distinguished botanist who had been on one of the voyages of exploration of James Cook. He was a great figure of his day and a personal friend of King George III, who took a benevolent interest in the society's affairs. During Bank's long presidency, Henry Cavendish and James Watt were making their important studies on the composition of water, Herschel discovered Uranus, and Volta was sending accounts of his electrical studies to the society. The society was taking an increasingly important part in public affairs. Humphry Davy succeeded Banks, and to mention briefly Michael Faraday, Charles Darwin, John Dalton, Clerk Maxwell, in addition to presidents such as Thomas Henry Huxley, William Thomson (Lord Kelvin), Joseph Lister, John Strutt (Lord Rayleigh), Joseph J. Thomson, and Ernest Rutherford is to give sufficient indication that there has been no lack of distinguished successors to the society's founders.

The number of fellows during the period from 1660 until Newton's death never exceeded 200, but from then until 1847 the fellowship grew steadily to a maximum of 764 fellows.

The year 1847 marked a very important change in the society's policy, inasmuch as very strict rules were introduced regarding the qualifications for election. Only 15 persons could be elected each year after 1847, and numbers fell steadily, being reduced to 469 in 1888. The 1847 rules had the result of changing the society within a generation from a body of well-educated and cultivated men of whom only about one-third could be classed as men of science to a scientific institution of the highest rank. In 1930 the number who may be elected was increased to 17, and in 1937 it was again increased to 20. In 1946 it was decided to increase it to 25, and the present fellowship is as given in Table 1.

There are three principal categories of fellowship under the patronage of Queen Elizabeth: (i) royal fellows, (ii) foreign members, and (iii) fellows. Category (i) consists of three royal dukes at present, including the Duke of Edinburgh, whose personal interest in scientific matters is an inspiration to so many British scientists. Foreign members (category ii), who may be elected at a rate of not more than four each year, include distinguished men of science from many lands, as Table 2 shows.

Category (iii) constitutes the main element of the society. To be eligible for fellowship, a scientist must be a British subject or a citizen of Eire, and he must be proposed and recommended by a certificate in writing signed by at least six fellows, of whom three at least must certify their recommendation from personal knowledge. About 250 certificates are examined each year by an elaborate machinery based on sectional committees, each dealing with a basic division of scientific activity—mathematics, physics, chemistry, engineering sciences, geology, botany, zoology, and physiology and medical sciences. The nomination procedure takes care of scientists working in borderline fields. Several months each year are spent in this very important matter of introducing new fellows judged "fit to joyne" the society. In 10 years, 250 fellows are elected, so that in a decade just under half of the category (iii) fellowship changes. If the choice of new fellows were not very carefully undertaken, the society's character could change very rapidly. Outstanding work of an original nature is a necessary achievement for election, and it is possible for a person influential in scientific affairs and well respected for his contribution in this regard never to attain fellowship of the Royal Society. The society does, however, have authority to elect at a rate of not more than one person per year a person who has either rendered conspicuous service to the cause of science or who is so distinguished that his election would be of signal benefit to the society. This authority is very sparingly used, and only twelve of the present fellowship were elected in this way.

A recent examination of the age of election of fellows shows that about 375 of the total were elected before they had reached the age of 50 years—all but 45 or so of these between ages 35 and 49. A. V. Hill, a former secretary of the society, recently calculated the median age of election for the different subject sections as follows for the years 1939–1953: mathematics, 42 years; physics, 44 years;

Table 1. Present fellowship of the Royal Society.

Date	Patron and royal (No.)	Foreign Fellows (No.)	(No.)
At 31 Dec. 1955	4	60	566
Elected 1956	0	4	25
Deceased to June 1956	0	2	11
At 27 June 1956	4	62	580

Table 2. Foreign membership of the Royal Society.

Country	Fellows (No.)
Argentine Republic	1
Austria	1
Belgium	1
Denmark	3
France	8
Germany	6
Netherlands	2
Norway	1
Soviet Union	1
Sweden	8
Switzerland	5
United States	23

chemistry, 45 years; engineering, 54 years; geology, 51 years; botany, 52 years; zoology, 50 years; physiology (including biochemistry and all medical sciences except anatomy, which comes under zoology), 49 years.

Geographical Distribution

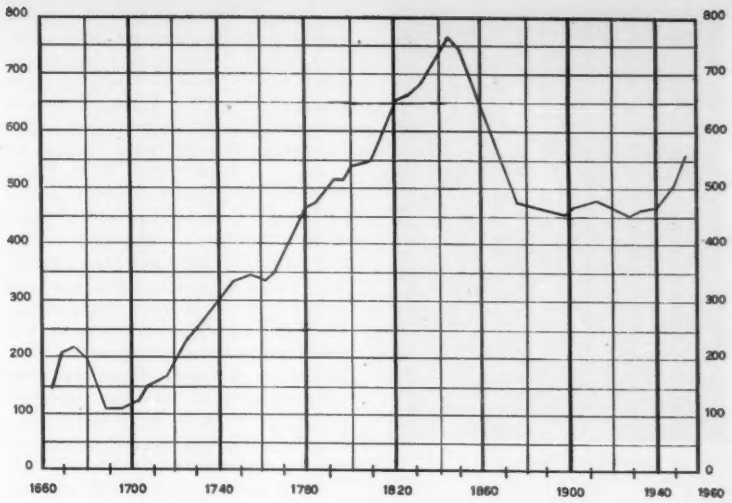
The distribution of fellows resident in member countries of the British Commonwealth is as follows: Australia, 14; Canada, 23; India, 5; New Zealand, 3; Union of South Africa, 2; Colonial territories, 3. In addition, it is of some interest that 11 fellows of category (iii) are resident in the United States. Several other fellows reside in other parts of the world.

Within the United Kingdom, 40 fellows reside in Scotland, seven in Wales, one in Northern Ireland, and three in Eire, and the others are mainly to be found in university centers throughout England. Table 3 shows the current distribution of fellows at universities in the British Isles. Several fellows occupy leading positions in industrial organizations and in government departments, and from this distribution it will be clear that the society can and does exercise a decisive influence on scientific research in the United Kingdom.

Although the present president, the distinguished chemist Cyril Hinshelwood, is at Oxford and his immediate predecessor, Edgar D. Adrian, is from Cambridge,

Table 3. Distribution of fellows at the universities in the British Isles on 27 June 1956.

University	Fellows (No.)
England	
Birmingham	11
Bristol	11
Cambridge	70
Durham	4
Exeter	2
Leeds	6
Liverpool	9
London	51
Manchester	10
Nottingham	1
Oxford	39
Reading	2
Sheffield	3
Southampton	1
Wales	
University Colleges	5
Ireland	
Belfast	1
Dublin	2
Scotland	
Aberdeen	2
Dundee	1
Edinburgh	14
Glasgow	7
St. Andrews	2



Number of fellows of the Royal Society, 1660–1955.

and at these two ancient universities are some 20 percent of the fellows of the Royal Society, it will be evident that the society's fellowship derives from a wide range of scientific centers both inside and outside the United Kingdom. It might be of some interest to mention eminent scientists who have worked or are working at some of these centers.

Scotland, Northern Ireland, and Wales

The great physicist Kelvin, president of the society 1890–95, was born in Northern Ireland and spent most of his life in Glasgow, bringing great renown to the department of natural philosophy of the University of Glasgow, where P. I. Dee continues the tradition with an active nuclear physics school equipped with an electron synchrotron. Three fellows lead active research groups in chemistry in Glasgow; J. M. Robertson, who delivered the George Fisher Baker lectures at Cornell University in 1953, is an acknowledged expert in the x-ray diffraction studies of organic crystals and molecules. D. H. R. Barton, who, like Robertson, has spent some time in the United States, has recently become a professor in the University of Glasgow, and his outstanding work in organic chemical synthesis attracts many research students. He was visiting professor at Harvard University in 1949–50. The third fellow is F. S. Spring, the Freeland professor of chemistry at the Royal Technical College, Glasgow, who has also carried out important work in organic chemistry. In marine zoology, C. M. Yonge's contributions to the study of Mollusca are well known, and Guido Pontecorvo is making significant contributions to the genetics of microorganisms.

In Scotland's capital city, Nobel prizeman, Edward Appleton, is vice chancellor of the University of Edinburgh. In spite of heavy administrative duties, he continues some studies in the nature and behavior of the ionosphere, where his pioneering work was so significant. Edinburgh University has had several fellows as vice chancellor in the past, notably Thomas Holland, the geologist, and Alfred Ewing, the engineer, and the scientific tradition is maintained by several active groups. N. Feather, a pupil of Rutherford, is continuing fundamental work on the study of the atomic nucleus. A. C. Aitken is head of the mathematics department, where previously the doyen of British mathematics, the late Edmund Whittaker, presided. Joseph Lister, president of the Royal Society from 1895 to 1900 and founder of the principles and practice of antiseptic surgery, was, at one time, a member of the medical faculty of Edinburgh University, which still enjoys a high reputation. Today there are five fellows in this faculty, J. H. Gaddum and Marthe Vogt (pharmacologists), G. F. Marrian and E. Stedman (biochemists) and D. Whitteridge (physiologist). C. H. Waddington is professor of animal genetics. E. L. Hirst, president of the Chemical Society, who has done very distinguished work in the field of carbohydrate chemistry, directs a large school in the chemistry department. The head of the chemistry department is J. P. Kendall, who recently retired from being president of the Royal Society of Edinburgh, which does much to encourage scientific research in Scotland.

Joseph Banks.

In the attractive town of St. Andrews, two fellows of the society conduct researches, John Read in organic chemistry and J. F. Allen in low-temperature physical phenomena. There are also two fellows in Aberdeen: biochemist W. O. Kermack and statistician D. J. Finney.

In Northern Ireland at the Queen's University in Belfast, there is research work in various disciplines being carried out; that directed by D. R. Bates on the fundamental constitution of the upper atmosphere is notable.

There are active centers of research in the constituent colleges of the University of Wales in Bangor, Aberystwyth, Cardiff, and Swansea. At Bangor, S. Peat has made important discoveries in carbohydrate chemistry and continues this work, and F. W. Rogers Brambell is making first-class contributions in embryological studies. At Aberystwyth is T. A. Stephenson, who is an artist as well as being a leading marine biologist.

England

In England there are several university centers where progressive research schools attract workers from overseas; for instance, Manchester University has a great reputation in physics and chemistry as well as in many other scientific fields. The chair of physics, now held by S. Devons, has been occupied by three Nobel laureates, Ernest Rutherford, Lawrence Bragg, and P. M. S. Blackett, and a stream of highly important original work has flowed and continues to flow from there. Associated with this department is A. C. B. Lovell's pioneering work on radio astronomy, soon to be further extended by the completion of the largest radio telescope in the world. The chair of organic chemistry, now held by A. J. Birch, has been distinguished by many British leaders of organic chemistry. Nobel prizeman Robert Robinson, president of the Royal Society from 1945 to 1950, held the chair from 1922 until 1928. Others who have held the chair since are Arthur Lapworth, Ian Heilbron, Alexander Todd, E. L. Hirst, and E. R. H. Jones. The chair of physical chemistry is now held by G. Gee, who is continuing his study of polymers, and he succeeded in this chair M. Polyani and M. G. Evans. The school of mathematics has also gained renown. In pure mathematics, M. H. A. Newman's work is well known, and in the mathematics department Kurt Mahler is professor of mathematical analysis. Newman has been associated with F. C. Williams in the design of a new computing machine and its application to mathematical research. M. J. Lighthill leads a very vigorous department of applied mathematics. In the biological sciences, S. C. Harland is professor of botany, and H. Graham Cannon is professor of zoology. Other fellows in the area are associated with engineering developments and medical sciences.

In Liverpool there are several chairs of chemistry occupied by fellows of the Royal Society: A. Robertson in the field of organic chemistry, C. E. H. Bawn in physical chemistry, and R. A. Morton in biochemistry. H. W. B. Skinner is the professor of physics and is a leader in neutron diffraction studies. R. J. Pumphrey occupies the chair of zoology. In the field of mathematics, L. Rosenhead is in charge of applied mathematics, and A. G. Walker in pure mathematics.

Liverpool, being one of Britain's principal ports, has had many leading figures in the field of oceanography. J. Proudman has just retired from the chair of oceanography, and A. T. Doodson is director of the Liverpool Observatory and Tidal Institute.

Birmingham, in the heart of the Midlands, has for long been a leading center of research, and it is the city with which are associated the names of Erasmus Darwin, Joseph Priestley, James Watt, and Matthew Boulton. Today the university has many chairs related to industrial developments, but in the field of pure science it also stands high. In physics, P. B. Moon has an active group working in the field of nuclear physics, and R .E. Peierls is in charge of mathematical physics. In chemistry, a large and active department is shortly to come under the leadership of M. Stacey with a wide range of interests in carbohydrate chemistry, fluorine compounds, polymerization, and so forth. F. W. Shotton is professor of geology. In biology there are many fellows of the Royal Society: D. G. Catcheside in microbiology, Lancelot Hogben in medical statistics, O. E. Lowenstein in zoology and comparative physiology, E. J. Maskell in botany, K. Mather in genetics, and Solly Zuckerman in anatomy.

In Yorkshire there are three universities—one quite new, at Hull. At the other two, at Sheffield and Leeds, there are many fellows of the society leading active schools in the field of physical and biological sciences. Mention might be made of the work in x-ray crystallography of W. T. Astbury and E. G. Cox at Leeds. R. D. Haworth at Sheffield is in charge of an active chemical research school there. Physics at Sheffield is in the charge of W. Sucksmith, while at Leeds the physics department is headed by E. C. Stoner. Sheffield is, of course, at the heart of Britain's metallurgical industry and has many active research workers in this field. It is also the center of glass-making.

The University of Reading has gained a reputation for leadership in the field of agricultural science; especially well known is the closely associated National Institute for Research in Dairying, ably led by H. D. Kay.

The University Colleges of Nottingham and Exeter have recently acquired university status, and J. W. Cook, a distinguished organic chemist, is the first vice chancellor of Exeter University.

In Northumberland, the University of Durham, with colleges in the cities of Durham and Newcastle, also has a strong contingent of fellows of the Royal Society on the university staff. In geology, for instance, there are K. C. Dunham of Durham and T. S. Westoll of Newcastle. W. W. Rogosinski is head of the pure mathematics department, and M. Thomas is professor of botany.

Bristol University also has many fellows of the Royal Society on the staff. The school of physics has done a great deal of distinguished work and is now in the charge of M. H. L. Pryce. One of his principal colleagues is C. F. Powell, Nobel laureate, whose work in cosmic rays has been so outstanding. Another is C. R. Burch, who numbers among his many inventions that of the reflecting microscope. Yet another is F. C. Frank in the field of metal physics, and also J. W. Mitchell, reader in experimental physics, who was elected into the fellowship only this year. Wilson Baker is the principal professor in an active school of chemistry. In mathematics, H. A. Heilbronn and L. Howarth cover the fields of pure and applied mathematics, respectively. Alfred Pugsley is professor of civil engineering, and in biology J. E. Harris is in charge of the zoological department.

Bristol was a city where Humphry Davy began some of his work in chemistry, and so we return to the man whose words began this article. During the 136 years since he addressed the fellows of the society, there has been no lack of

effort to follow his dictum. I have purposely left out of this description of the fellowship any detailed mention of the very active departments of research at the Universities of Oxford, Cambridge, and London, because these are usually better known; the fact that there are other very active scientific research centers in the United Kingdom is perhaps not as well appreciated in other countries as it might be.

The Royal Society seeks to recognize and encourage scientific research wherever it is carried out. Through its award of medals, the invitations it issues to scientists to lecture or to read papers before it, and by its maintenance of the highest standard in its publications, it will continue to exert a not inconsiderable influence on the course of research in the natural sciences.

Graduate Students in Britain

H. N. V. Temperley

Graduate students in Britain vary enormously. They range from the strictly "dedicated" person to the man who merely regards the Ph.D. as an additional qualification for getting a good job. In personality, they range from the carefree, sometimes almost childish, individual to the serious and earnest seeker after truth. Sometimes they seem to be working under continuous strain; the worried face and the tic that goes with it (often coupled with brilliant work) is probably represented in any research group of any size. As in the United States, it has been found that a research director cannot look after more than about six students with any efficiency, so that the head of a group of any size has to delegate a great deal of this work to others.

The success or failure of a student depends very much on the stimulus he gets from his director of research, who is a far more important influence than is the graduate student adviser in the United States, for reasons that will be explained in a subsequent paragraph. There can be no question that the student who has a really good research director at the beginning of his career has an immense advantage, and such an experience is quite unforgettable, as many of the former students of Rutherford and R. H. Fowler will testify.

The problems facing a director, such as that of guiding a student into profitable channels and yet avoiding bullying, of telling him tactfully that his cherished idea is unsound or not new, of striking the happy mean between "spoon-feeding" and unduly neglecting his students, of advising them about their personal problems and future plans, and of seeing that they all get proper credit for their work, have probably always existed, but a further complication is becoming evident today on account of the trend of research itself, the tendency being more and more toward work in large teams on big projects. The attempt to expand a flourishing team can lead to disaster. It by no means follows that a first-rate individual researcher can lead a team of six with any success: the relationship between a student and his director is always rather delicate, and it is almost impossible to repair the damage once a real "blow-up" has occurred. Still less does it follow that such a man can successfully run a department of 30 or more; he may resent the inevitable load of administration, which he considers to be "waste of time," he may find that its problems fascinate him as much as his now neglected research and students once did, or he may make a heroic effort to do both parts of the job at high pressure and end up with an ulcer. Thus, the personality of the director influences the students enormously. It is possible to inspire better work in others than one can do oneself, as Barrow inspired Newton.

Beginning Graduate Work

The main differences between a British graduate student and his American cousin arise from their different educational backgrounds. In the first place, a British boy has to be fairly bright to get into a university at all, the percentage of population being far smaller than in the United States. No one has any prescriptive *right* to a place in a college, each of which has its own special system of selecting candidates. Secondly, he will already have done at school most of the work that is usually done during the freshman year in the United States, and, at the end of his 3 undergraduate years, he will be in about the same position as is a second-year graduate student in the United States. His chance of becoming a graduate student depends mainly on his undergraduate degree.

Nearly everyone at college *passes* his final examinations, but he would not usually be considered to be graduate student material unless he finished up with a "First Class." The type of man who would be elected to Phi Beta Kappa in the United States would probably get a good "First Class" in England. Quite a few of the research grants also go to those who are fairly high in the "Second Class." (This probably corresponds to a minimum grade average of about 6.5 out of 9.)

Having attained this standard, he will probably be awarded some research grant or scholarship. The system for handing these out is complicated, and is administered partly by the Government and partly by the universities themselves, the money coming partly from taxes and partly from private endowments of many kinds. In practice, a man without private means gets enough to pay his fees as a graduate student and to enable him to live in a fairly simple style. Unlike his American cousin, he is not specifically required to do any work outside his research program in return for this money; indeed, the outside work he may do is usually limited to a little teaching or laboratory demonstration during termtime. Some students earn a little extra money during the summer vacation, but control on the type and length of job is often exercised here too. Most of our graduate students are unmarried, our convention being that a man lines up a safe job before considering marriage.

The third main difference is that the British graduate student is given a great deal more freedom to organize his own program than his American cousin is

The author, who resides at Riversdale, Grantchester, Cambridge, England, has had about 10 years' experience in directing the research of others at the British Admiralty and at Cambridge University. He has spent a total of about 2 years in the United States, where he has held various visiting appointments at Yale University, the University of Nebraska, and the National Bureau of Standards. In addition, he has made short visits to about 15 other universities. His experience has been with mathematics and the physical sciences, but he feels that the situation of students in the other subjects is not very different.

given. He very often stays on at his original university. If he moves to another, there is usually some specific reason—for example, he may have quite decided about the field in which he wishes to work, and there may be no suitable supervisor available at his original university. Once he has been accepted by a university and has found a supervisor, the actual requirements imposed on him are relatively light. The university does not usually *force* him to attend specific courses of lectures, although there are always plenty of courses *available* at an advanced level, nor is he usually required to take any more examinations until the time comes to present his thesis. In fact, the *formal* requirements amount to little more than "residing" for a certain number of days each year, our system thus resembling the German one, from which it is said to have been copied.

As we have seen, the British student will probably have done as an undergraduate some of the work that is left until the graduate student stage in the United States, but it is nevertheless true that our system throws very much more responsibility both on the supervisor, who is really the only person who can speak with any authority on the student's progress and prospects, and also on the head of the laboratory or department, who may have to step in for many reasons—for example, if the first research problem turns out to be a "dud," or to be a bigger job than was at first thought, or if "supervisor trouble" develops. If a student is obviously not the research type after all, he is usually told so tactfully after a year or so, and he takes the hint; it is very seldom necessary to force him to go by withdrawing his grant. A supervisor who let a weak student "drift" for any length of time would be considered to have failed in his duty.

Thesis

So we come to the final stage when the student presents his thesis. The arrangements for evaluating the thesis are very similar to those in the United States, the award of the degree depending partly on the thesis itself and partly on a fairly formidable oral examination in which the student is required both to defend his thesis and also to show a sound general grasp of his field of work. It is fair to say that the volume of original work expected is distinctly higher than it is in the United States, but this is reasonable in view of the fact that the student has been working on his problem almost full time for 3 years. The American Ph.D. degree may represent more than 3 years of time, but much of this will have been taken up with graduate courses and examinations, and probably also with earning enough money to keep going, so that the time actually spent on the problem may well be a good deal less.

Research Careers

We need say little more about the person who regards his British Ph.D. merely as a qualification for a job, which he chooses and takes up in exactly the same way that a person with a bachelor's degree would do. The fun is only just starting for the person who wishes to make a *career* in pure research.

Elsewhere, I have reviewed the many problems [*Nature* **177**, 455 (1956)], that seem to me to face such a person in the United States, and I have, as a result, had a number of kind letters from people with many more years of experience who have reached similar conclusions. I therefore feel justified in putting on record my impressions of the same problems in Britain, which seem to me to be very similar. Although the problem of giving the research man a living, and yet securing that he does a reasonable job of work for society in return, has been with us for hundreds of years, we have not yet found a satisfactory solution. (The life fellowships of the Oxford and Cambridge colleges were abolished, for various reasons, in the 1920's.) The difficulty is, of course, that a research career that begins well may, in a minority of cases, degenerate into an output of philosophic trash, "science fiction," and wild suggestions, or may even come to an end through sheer laziness. The hard fact is one that has often been stressed, namely, that society must be prepared to give a researcher a very free hand if it wants research to be done effectively, and it is inevitable that society will be occasionally let down.

What of the researcher who thinks that the universities are the true home of fundamental research and wishes to work there? There are quite a number of postdoctoral fellowships of various types so that the first few years are not really a serious problem to a good man, while anyone who does not secure something of this kind would be well advised to drop out.

At the end of such a fellowship, a researcher is likely to run into fierce competition with his contemporaries for staff jobs at the universities. These are always in short supply, in marked contrast to the number of vacancies in industry, our situation in this respect being very similar to what I found in the United States. Even if he gets such a post, his troubles are still not over. He will, nearly always, be expected to carry quite a heavy teaching load, although he may have no real aptitude for teaching, and the fact that he has proved himself capable of creating new knowledge is no guarantee at all that he has the ability to pass elementary knowledge on to others, or to direct laboratory classes. In addition, he faces the fact that it will probably be several years (at Cambridge it can be eight in an extreme case) before he is appointed permanently to the staff and is able to plan ahead with some confidence. It seems hardly right that such a man should be burdened with this uncertainty, and be afraid to disagree even on minor points with the head of his department, and that he should be weighed down with a heavy teaching load at the very time when he has plenty of research experience behind him and yet is not too old to use it to the best advantage. A few university posts do specify research and the direction of research as the main duties, but there is an undoubted tendency on the part of many of the teaching staff to look on such appointments with suspicion, claiming that teaching is the primary function of any university, and sometimes even hinting that research is something that young people do until they are old enough to know better! With the present expansion of demand for scientists and engineers, it is indeed true that the teaching must somehow be done, even if the staffs are overworked, and even if some of their research is crowded out. It then becomes difficult to create posts with no teaching duties at all, or to employ staff who are poor teachers.

From the practical point of view, the research scientist in industry or in government service is probably better off than his university colleague, both financially and from the point of view of the time that he actually has available for research. Again, this is in line with what I found in the United States. The fact that his boss will usually call for some "bread and butter" work in return for the money that is spent on him is no more than just, provided that the researcher is also allowed to plan some of his work for himself. Although more and more industrial firms seem to be expanding, or creating, research departments, the queues for staff appointments at the universities seem to be as long as ever; "the lure of the ivory tower" seems to be at least as strong in Britain as it is in the United States. It is not easy to explain this fascination in concrete terms. As a race, we have an innate respect for learning and scholarship for its own sake, so prestige probably plays its part. The love of teaching is *not* the complete explanation, for many people who are interested in university posts would not even consider a school job—indeed, we face a serious shortage of science teachers in the schools. The basic ambition is probably to build up a flourishing group of young workers whose reputation shall attract others. It is difficult to do this anywhere except at a university, but this may change in the course of time, when research institutes of other types have had time to build up reputations.

News of Science

Storing Molecular Fragments

The National Bureau of Standards has developed a technique for capturing and storing large numbers of highly reactive molecular fragments at temperatures near absolute zero. In this method, unstable atoms and free radicals, known to exist but momentarily in flames and hot gases, are produced in an electric discharge, frozen into immobility, and trapped in solid form. Because these atoms are frozen in the excited state, they can be conveniently studied by optical spectroscopy.

In experiments to date, the bureau has produced solids containing atomic nitrogen and oxygen, and possibly atomic hydrogen and an unstable hydroxy (OH) molecule. These solids have very unusual properties, emitting bright glows, blue "flames," and colored flashes of light. When warmed 20 or 30 degrees, they combine very actively, releasing large quantities of stored energy, principally as heat. Possible fields of application for this new method include studies in solid state physics and basic chemistry, in which the trapped atoms could be used as powerful probes into the solids containing them. From a study of their properties, information could be obtained about the arrangement of the atoms and molecules in the solid and about the forces acting on them. The mechanism of atomic diffusion and of reactions between atoms and molecules also could be studied.

The technique has the advantage that the free radicals are stored in highly excited states as a result of the electric discharge, making it possible to study and analyze them by spectroscopic techniques. Also, because the radicals are collected at much lower temperatures than in previous methods, they can be stored longer in the uncombined form.

In this method, gases containing molecules of nitrogen, hydrogen, oxygen, or water are first passed through a high-frequency electric discharge, then frozen very suddenly at 4.2°K, just a few degrees above absolute zero.

The discharge is maintained in a waveguide resonator by a 2,450-Mc power supply. From the resonator, a glass tube leads the resulting molecular fragments into an evacuated metal vessel containing a cold surface in contact with a liquid helium bath. To prevent solidification of the discharge products at temperatures above 4.2°K, the gases are carried to the cold surface through a passageway that is kept near room temperature by contact with warm helium gas. When the gases reach the cold surface, they freeze into solid form there.

Because the free radicals produced by this method can be kept unchanged for many hours, a more detailed study of their properties has been possible than in previous work. For example, during the discharge through nitrogen the condensed solid emits a bright green glow, which tends to become yellow at high flow rates. The spectra obtained from this glow show that the structure of the solid condensed from the discharge differs from that of ordinary solid nitrogen. In fact, each atom of the condensed nitrogen forms a very loosely bound complex with some neighboring molecule, and this complex has properties that differ from those of the separate atom and molecule. The evidence shows that the complex is a definite unit. By analyzing its spectra, the forces holding it together can be studied.

Public School Growth

The Department of Health, Education, and Welfare has recently completed a study of the growth of the public school system in the continental United States (48 states and the District of Columbia) in the bienniums from 1951–52 to 1953–54. The total school population was at an all-time high, but secondary school enrollments were below the peaks reached in the 1930's. During the biennium from 1 July 1951 to 1 July 1953 the school-age population (ages 5 to 17 years inclusive) increased by 3.2 million (an increase of 10.1 percent) to reach 34.5 million. At the same time enrollments in the public schools increased from 26.6 million in 1951 to 28.8 million in 1953, an increase of 8.6 percent.

The total instructional staff increased by 86,000 to reach 1.098 million. Expenditures for public elementary and secondary schools amounted to $6.833 million in 1953–54, a rise of 19.7 percent over the $5.753 million spent in 1951–52. The total educational cost for 1953–54, when expenses for summer schools, community colleges, adult education, and so on are included, amounted to $9.092 million. Of this total $2.055 million went for capital outlay, a record high.

The report analysed salaries as follows:

"The average annual salary of the total instructional staff (supervisors, principals, teachers, etc.) was $3,825 in 1953–54 as compared with $3,450 in 1951–52, a rise of 10.9 percent; however, when adjusted to reflect the decrease in the purchasing power of the dollar, the average salary increased by 8.4 percent during the 2-year period. During the same period, the personal income (in 1953–54 dollars) per member of the labor force rose from $4,073 to $4,245, an increase of 4.2 percent. That instructional staff salaries still lag behind the gains made by the total labor force is indicated by the fact that during the period 1940–1954, the personal income of the labor force increased 62.3 percent compared with an increase of 37.8 percent in instructional staff salaries. A State-by-State analysis of instructional staff salaries in 1953–54 reveals that in 1 State the average salary was less than $2,000, in 12 States between $2,000 and $3,000, in 20 States between $3,000 and $4,000, and in 15 States the average was over $4,000."

International Cancer Statistics

Facts concerning cancer of the digestive organs and peritoneum are to be found in a statistical publication issued by the World Health Organization on the mortality from such malignant neoplasms in 26 countries since the beginning of the century. Mortality from cancer of the digestive organs is higher in men than in women.

Stomach cancer is responsible for the majority of cancer deaths in both sexes, immediately followed by cancer of the large intestine and the rectum. In England in 1953, 44.5 percent of all cancer deaths were caused by cancer of the digestive organs; in Spain, 48.9 percent; in France, 50.1 percent; in Italy, 54.6 percent; in Sweden, 52.7 percent; in Switzerland, 50.6 percent; in Canada, 46.7 percent; in Chile, 62.6 percent; in the United States, 39 percent; in Uruguay, 54.6 percent; and in Japan, 73.3 percent.

A remarkable increase in cancer deaths since the beginning of the 20th century is clearly shown in the statistical tables of the WHO report. Among the many possible causes of this rise is the aging of the population. Because cancer starts mainly around middle age, the fact that people live longer means that more of them may be struck by this disease. Fur-

thermore, in the past 50 years other causes of death such as the infectious diseases have lost much of their importance, thus increasing the proportion of deaths caused by cancer.

Michigan Reactor Controversy

The Atomic Energy Commission has granted a conditional construction permit to the Power Reactor Development Company of Detroit for the building of a nuclear power plant near Monroe, Mich., with a capacity of 100,000 kilowatts of electric power. The plant, which will be known as the Enrico Fermi Atomic Power Plant, will have a reactor of the fast-neutron breeder type.

The Power Reactor Development Company is composed of 26 industrial concerns, more than half of which are utility companies. The power generated by the nuclear plant will be distributed by the Detroit Edison Company, one of the member industries.

The permit covers only construction of the nuclear plant and does not extend to its operation. However, issuance of the permit has evoked strong protests. The AEC's advisory committee says that not enough is known about fast nuclear power plants to rule out the possibility of a dangerous failure. On the strength of this opinion, Thomas Murray, a member of the commission, and Sen. Clinton P. Anderson and Rep. Chet Holifield of the Joint Congressional Committee on Atomic Energy, have objected to the commission's conditional approval of the new reactor. In a statement to the press Holifield said:

"A small experimental operation of a fast-breeder type reactor "melted down' in Arco, Idaho, last November. There was no serious reaction because the operation was only a tiny laboratory experimental type, but it was an 'accidental' melt-down from causes not foreseen. As far as we know the same thing could happen to the 100,000-kilowatt plant the AEC has approved for Michigan."

Belgian Reactor Ban

Public fears in Belgium have led to the banning of the reactor that was to have been exhibited at the International Exposition to be held in Brussels in 1958. However, a pilot model with a capacity of about 11,000 kilowatts may be built within easy distance of the city. Some of Belgium's leading industrialists in the power production field have been in the United States discussing this and related matters with the Atomic Energy Commission and private industry.

According to a report in the *New York Times,* the Belgians are no more concerned than others about radiation danger. However, on the basis of available information the citizenry feel that the operation of even a pilot model within the city limits seems to be a "needless, even a foolhardy risk." Belgium is by no means behind in matters of nuclear energy. Because she possesses one of the world's largest sources of uranium, Belgium has received special treatment with regard to the exchange of information and materials and therefore has a well-advanced atomic energy program.

South African Observatory

Six European nations are considering building a joint observatory in South Africa that will be second in size only to Mount Palomar in the United States. The South African observatory would have a 120-inch telescope compared with Mount Palomar's 200-inch unit. The nations involved are Britain, France, West Germany, Sweden, and the Netherlands.

Pieter T. Oosterhoff of Leiden Observatory, who is leading a joint European southern observatory expedition on a survey of possible sites in South Africa, says that all of these countries, except the United Kingdom, have approved the project in principle. Individual financial contributions are yet to be agreed upon, and the U.K. is expected to make known its decision at the next meeting of the group to be held at Stockholm in October.

U.K. University Population

Wallis Taylor has estimated the size of the university-age population (18, 19, and 20 years) to be expected in the United Kingdom for each year up to 1972 [*Nature* **178**, 135 (21 July 1956)]. The estimates are based on forecasts for the survival of children already born, with allowances for the decreasing mortality this population has shown.

The population in this age group was 1.64 million in 1955. According to the estimates, the population will increase by 42 percent to reach a maximum of 2.34 million in 1966, and will decline steadily to 1.95 million in 1972. Taylor's figures indicate that the peak number of students who will be seeking university education will be larger than had hitherto been expected.

University Research in the Soviet Union

The role of universities in research in the Soviet Union is undergoing a major change, according to the *New York* Times. The Soviet Government has ordered the transfer of a number of research institutions from the control of the Soviet Academy of Sciences to that of the universities. The Ministry of Higher Education, which controls the universities, will compile a plan that will stipulate the most important areas for research. It is expected that universities will work on automation of production, development of semiconductors, the application of oxygen to metallurgy, the chemistry of radioactive substances, nuclear physics, machine tool design, the increase of crop yields, and so on.

Officials of the Soviet Academy of Sciences will be put under increased pressure to produce research results by a competitive device. One-fifth of the senior scientific posts will be put up annually for open competition. Formerly, such posts were lifetime assignments.

Genetics Congress Resolution

At the final session of the International Congress of Human Genetics which met recently in Copenhagen, Denmark, Herman J. Muller of the University of Indiana proposed the following resolution on radiation danger. It was passed unanimously by the approximately 400 participants.

"The damage produced by radiation on the hereditary material [of man] is real and should be taken seriously into consideration in both the peaceful and military uses of nuclear energy as well as in all medical, commercial and industrial practices in which X-rays or other ionizing radiation is emitted.

"It is recommended that the investigation of the amount and type of damage and of related genetic questions be greatly extended and intensified with a view to safe-guarding the well-being of future generations."

National Bureau of Standards To Be Moved

A tract of approximately 550 acres of land near Gaithersburg, Md., has been selected for relocation of the Washington laboratories of the National Bureau of Standards. The move will permit the bureau to plan new buildings to replace present research facilities, which have become inadequate for current needs. The new site was selected as most suited to the special requirements of the bureau's scientific and engineering programs. The choice was based on a number of factors, including accessibility by railroad and highway as well as topography for certain technical projects.

Congress appropriated funds for site acquisition and preliminary planning early in June after details about the pro-

posed site had been presented to House and Senate Appropriations Committees. Plans for the site have been given to the National Capital Planning Commission and to the Regional Planning Council, and it is expected that these groups will work with the bureau in utilizing the land. The General Services Administration will participate in planning and will supervise construction. Transfer of operations to the new location is expected to be completed in about 5 years.

The bureau occupied its present site on Connecticut Avenue in Washington in 1903. Since that time its responsibilities have greatly increased, largely as a result of the rapid expansion of technology and the growth of scientific research. Extensive programs of research and development must now be conducted in the physical sciences and engineering to meet the needs of science and industry for new and improved standards and measurement methods.

It is expected that the new location will make possible a more modern research operation in structures that can be very efficiently managed. In addition, the rural location will remove the bureau's work from the variety of mechanical, electric, and atmospheric disturbances present in a city and will reduce the effect of these forces on precise scientific measurements.

In addition to its Washington laboratories, the bureau maintains a major research center in Boulder, Colo., and 20 widely scattered field stations. The Boulder laboratories are concerned with radio propagation research, radio standards, and cryogenic engineering. Most of the field stations are engaged in gathering data on radio propagation.

Science, Secrecy, and Wall Street

It is perhaps of interest to note that recently the *Wall Street Journal* carried a full-page condensation of testimony on "The High Cost of Secrecy to Science" given by Gerard Piel, publisher of *Scientific American*, before the House Government Information Subcommittee. The article ends with the following paragraphs.

"Under our Constitutional principle of the separation of powers, our Congress has long opposed the human tendency in the Executive Department to make Government a private affair. It is an old experience in the administration of our country that secrecy can be a shield for incompetence and corruption.

"Now we have a new reason to oppose secrecy in the operations of the Government. It is the danger that secrecy lays to the advancement of science, and hence to the general welfare and to national security."

Nuclear Progress in India

India's first atomic reactor went into operation on Trombay Island, 13 miles from Bombay, on 4 Aug. This is the first reactor to be set up in Asia. Japan is running just behind India in the atomic field; its first reactor is due to start operating shortly.

The Indian reactor will turn out radioactive isotopes for use in biological, medical, and industrial research, and will be used to train nuclear scientists for further projects. A second reactor, provided by Canada under the Colombo Plan, will start operating by 1958. This will also be set up at Trombay, and will be a high-power, high-flux machine that will enable India to undertake advanced engineering research and the testing of materials connected with the more advanced types of power reactors.

To feed the reactors, India has vast potential supplies of atomic fuel. The beaches of Travancore-Cochin are rich in black monazite sands, bearing uranium, thorium, and zirconium. The thorium content of the sands is estimated at 100,000 tons—the biggest thorium deposits in the world. In Rajasthan, deposits of beryl have been discovered, and uranium-bearing materials have been located in Bihar, Udaipur, and Nellore.

A plant has already been operating for 4 years at Alwaye in Travancore-Cochin to process monazite sands for the extraction of uranium and thorium "cake." A second plant at Trombay processes the cake for the production of small quantities of pure thorium nitrate and uranium. Two more atomic fuel plants are being planned: one plant will extract uranium from copper tailings; another, to be set up at Nangal in the Punjab, will turn out heavy water as a byproduct of nitrogenous fertilizers.

The training of special workers was begun 11 years ago by the Tata Institute of Fundamental Research, so that when the government established its Atomic Energy Commission in 1948 there was already a small team of trained nuclear physicists. Today, there are 200 natural scientists on the staff of the Atomic Energy Commission's establishment at Trombay. By 1959 there will be 800.

In addition to Canada, other foreign countries have also helped Indian nuclear development. Britain has signed an agreement with India for "close cooperation and mutual assistance" on the peaceful uses of atomic energy and is providing enriched uranium as fuel for the first reactor. A British firm of consultants is helping to plan the heavy-water factory at Nangal.

The United States is also ready to cooperate with India and is supplying 21 tons of heavy water for use in the second reactor. France has been cooperating in the processing of the monazite sands. The U.S.S.R. has offered India any information needed on peaceful uses of atomic energy. India is also cooperating informally with Norway and Sweden.

Larger Orbit for Satellite

Improvement in the performance o the launching vehicle for the IGY earth satellite, including a reduction in the vehicle's weight, has led to new estimates for the orbit that may be attained, according to those in charge of Project Vanguard in the Office of Naval Research. It is now estimated that a satellite may attain a final velocity of 19,000 miles per hour instead of 18,000, and an elliptical orbit that could reach a maximal distance from the earth of some 1500 miles instead of the 800 originally predicted. Spokesmen for the project indicate that developments have gone better than expected and that recent rumors about unexpected difficulties are unfounded.

Heavy Water in Germany

The production of heavy water is of great importance in the atomic energy program. How far this program can compete with ordinary power stations depends to some extent on the price of the heavy water.

H. C. Urey and collaborators discovered the heavy hydrogen isotope in 1932 by the fractional evaporation of liquid hydrogen, and in 1943 Urey and engineers at the DuPont Company considered its industrial use. However, it was Clusius who suggested independently in 1941 that heavy water might be produced on an industrial scale by rectification of liquid hydrogen. He gave detailed calculations in 1949, and now K. Winnacker, Frankfurt (M)-Hoechst [*Physik. Bl.* **12**, No. 6, 274 (1956)], reports that an installation is being set up in cooperation with Linde Eismaschinen for a production of 6 tons of heavy water per year.

As starting material for the heavy hydrogen, ammonia synthesis gas of about 70 percent hydrogen, 20 percent nitrogen, and some impurities is being used. (The exact composition may vary from plant to plant. For example, at the Phillips plant in Etter, Tex., the gas contained 72.2 percent hydrogen, 24.1 percent nitrogen, and various impurities). Since in normal hydrogen only 1 atom of heavy hydrogen in about 7000 atoms of ordinary hydrogen is present, large amounts of synthesis gas (8500 cubic meters per hour) have to be processed. By cooling this gas with liquid nitrogen under a pressure of 8 atmospheres, most of the nitrogen is removed. The last traces of impurities

are removed at temperatures of between 30° and 60°K. Next the hydrogen is liquefied and distilled at 20°K in rectification columns.

This process leads to 90 percent HD. By warming this to room temperature, using a catalyst, a mixture of light and heavy hydrogen is obtained; this mixture is again cooled to liquid hydrogen temperatures, again rectified, and finally 99.7 percent deuterium is obtained. The deuterium is burned with oxygen to heavy water, which can be used directly as a moderator in reactors.

This is the first time that large amounts of liquid hydrogen have been used in a technical production line, although the French Atomic Energy Commission has authorized the Societé de l'Air Linde to build a plant for this purpose at Toulouse. For American plans and a review of the various processes, see M. Benedict in *Peaceful Uses of Atomic Energy* (United Nations) [8, 378 (1956)].—K.L.-H.

News Briefs

■ The Canadian Meteorological Station at Departure Bay, Vancouver Island, will soon launch 15,000 bottles on the Pacific Ocean, one of the most extensive projects of the kind ever carried out. The bottles will be used for a survey of ocean currents and the launching will be done by about 30 ships, the most distant one being 1500 miles from shore. For more than a year, J. Tully, who is in charge of the experiment, has been collecting old bottles, for new ones are somewhat more fragile. The number of bottles that return to Departure Bay is not expected to exceed 2 percent, or 300 bottles.

■ President Eisenhower has signed the bill authorizing construction of an atomic powered merchant ship. No limit is set on the cost of the vessel, but it has been estimated at about $40 million.

■ Moscow Radio reports that a station to study cosmic rays is to be built near Alma Ata, capital of the Soviet Central Asian State of Kazakhstan. The station will be more than 10,000 feet above sea level.

■ Jayaprakash Narayan, former leader of the Socialist party in India, has come out strongly in favor of banning the slaughter of cattle, according to the *New York Times*. Twelve Indian states already have laws banning cattle slaughter, and in others the question is a divisive issue and a matter of debate. Prime Minister Nehru has opposed legislation to enforce the ban.

The latest official figures are for the year 1951, when there were 155.5 million cattle and 43.3 million buffalo in India. This is 19 percent of the world's cattle population and more than half the world's buffalo. Opponents of the ban on slaughter point out the magnitude of the economic burden involved in maintaining the old and useless animals and hold that it retards any real progress in the development of Indian agriculture.

■ Recent legislation passed by Congress authorizes the expenditure of $400,000 to enable the World Health Organization to hold its 11th World Assembly in the United States in 1958.

Scientists in the News

ROGER BARNES, chairman of the department of urology at the College of Medical Evangelists School of Medicine (Los Angeles), is now in Vellore, India, lecturing on urology at the Christian Medical College. He will return to his post next July.

Also at the College of Medical Evangelists, J. E. THOMAS will commence a 3-year interim appointment as visiting professor and chairman of the department of physiology in September.

EILEEN R. CUNNINGHAM, librarian for the Vanderbilt University School of Medicine, retired on 1 July after 31 years of service. In recognition of her work with medical and nursing school students, Mrs. Cunningham was appointed professor of medical library science in 1949. She was elected president of the Medical Library Association in 1948, and received the first Marcia C. Noyes award for outstanding achievement in medical librarianship to be given by that association.

She has headed a number of important national and international library committees, and she has participated in many international conferences. In addition, she has been active in promoting the recently organized International Association of Medical Libraries.

Mrs. Cunningham is the author of *Classification for Medical Literature*, a system that is in use in many libraries in various parts of the world. She is also a coauthor of the annotated *Bibliography of the Reference Works and Histories in Medicine and the Allied Sciences.*

She is succeeded at Vanderbilt by ELEANOR G. STEINKE, assistant librarian since 1946.

LEROY E. BURNEY has been sworn in as Surgeon General of the U.S. Public Health Service. The appointment is subject to Senate confirmation. Burney, who has been serving as Assistant Surgeon General and deputy chief of the PHS Bureau of State Services, succeeds Leonard Scheele, who resigned on 1 Aug.

The following awards were made during the recent annual meeting of the American Society for Engineering Education:

LLEWELLYN M. K. BOELTER, dean of the College of Engineering at the University of California in Los Angeles, received the Lamme medal for contributions to teaching, research, administration, and the advancement of the profession.

CLIFFORD C. FURNAS, chancellor of the University of Buffalo who is on leave to serve as Assistant Secretary of Defense for Research and Development, received the Vincent Bendix award in recognition of outstanding contributions in engineering college research and its administration.

MILTON C. SHAW, professor of mechanical engineering at the Massachusetts Institute of Technology, received the George Westinghouse award, which is given to a young engineering teacher for achievement in teaching.

CHARLES S. JONES, president of the Academy of Aeronautics, LaGuardia Airport, New York, received the $500 James H. McGraw award for leadership in 2-year technical institute education.

RALPH J. PAFFENBARGER, head of the department of engineering at Ohio State University, received a citation for distinguished service in his profession.

C. H. LI, metallurgist in the tube division of the Radio Corporation of America, Harrison, N.J., received the $100 Gessner prize in nomography for the best graphical representation of a mathematical equation published in 1955–56.

EDWARD U. CONDON, head of the department of physics at Washington University (St. Louis), has been named editor of *Reviews of Modern Physics*, quarterly journal of the American Institute of Physics.

CHARLES S. CAMERON, medical and scientific director of the American Cancer Society, has been appointed dean of Hahnemann Medical College, effective 1 Nov. He will fill the post that was left vacant when CHARLES L. BROWN resigned to become head of the Seton Hall University Medical College.

THEODORE E. STERNE, a specialist in weapons systems evaluation, has been appointed associate director of the Astrophysical Observatory of the Smithsonian Institution in Cambridge, Mass., and Simon Newcomb professor of astrophysics at Harvard University.

SAMUEL B. BATDORF, physicist, formerly of the Westinghouse Electric Company, has joined Lockheed's Missile Systems Division as assistant director and head of the electronics division.

BENJAMIN B. WELLS, director of the department of medicine at Creighton University (Omaha) has been appointed to the newly established position of director of clinical investigation at the Lynn Clinic, Detroit, Mich. He will assume his post on about 1 Sept.

PETER L. KAPITSA, Soviet nuclear physicist, has been restored to his post as director of the Institute for Physical Problems, Moscow, after 7 years of house arrest suffered because he refused to devote himself to nuclear weapons research. Western physicists who visited the U.S.S.R. this summer to attend conferences say that Kapitsa and a number of other scientists who had been arrested, including some who had been exiled to Siberia, have been returned to their laboratories and are being permitted to mingle freely with visiting foreign scientists.

Richard M. Bozarth of Bell Telephone Laboratories, a participant in the recent conference on magnetics of the Soviet Academy of Sciences, said in a statement to the press:

"At present, there seem to be no barriers to personal and scientific contacts. [Soviet] . . . scientists want to be friends. They want to get together with us. They would like to visit the United States."

Bozarth commented further that he was shown every piece of apparatus that he desired to see and that every scientific subject that he raised was discussed with apparent freedom.

Recent Deaths

REUEL A. BENSON, New York, N.Y.; 78; professor of graduate pediatrics and retired professor of pediatrics at New York Medical College; founder of the Frederick S. Wheeler Laboratory; member of the editorial board of *Archives of Pediatrics*; 6 Aug.

GLENN BRIGGS, Washington, D.C.; 65; research agriculturist in charge of technical assistance training programs, Department of Agriculture; former professor at Oklahoma Agricultural and Mechanical College; 4 Aug.

SAMUEL BRODY, Columbia, Mo.; 66; professor of dairy science at the University of Missouri; 6 Aug.

GUSTAVO CUMIN, Catania, Italy; 60; volcanologist who was an authority on Mount Etna; 7 Aug.

GEORGE H. HOGEBOOM, Bethesda, Md.; 43; pioneer investigator of the biochemistry of subcellular particulates; head, cellular biology section, National Cancer Institute, National Institutes of Health; 5 July.

WILLARD N. HOLMES, Ocala, Fla.; 93; expert in oil chemistry; Patent Office official from 1908 to 1934, who was recalled to government service in the office of the Alien Property Custodian at the age of 80; 2 Aug.

HAROLD G. LITTLER, Montreal, Canada; 55; former manager of the plastics division of Canadian Industries, Ltd.; 2 Aug.

WILLIAM J. MALLORY, Lovettsville, Va.; 81; professor emeritus of medicine at George Washington University; 1 Aug.

WILLIAM MEADOWCROFT, New York, N.Y.; 80; retired civil engineer; 6 Aug.

Rev. JOSEPH J. MOLLOY, Philadelphia, Pa.; 52; head of the chemistry department at St. Joseph's College; 2 Aug.

CHARLES F. MORSE, Patchogue, N.Y.; 85; civil engineer; 4 Aug.

IVAR T. TIDESTROM, St. Petersburg, Fla.; 91; retired Agriculture Department botanist and retired botany teacher at Catholic University; 2 Aug.

JOSEPH A. TRENT, Shawnee, Okla.; 56; professor of biology and chairman of the department at Oklahoma Baptist University; 21 July.

SIDNEY WILLIAMS, Chicago, Ill.; 70; safety engineer; 5 Aug.

Education

■ The Department of Agriculture will open a new forest research center this fall at Sewanee, Tenn., in cooperation with the University of the South. The center will be one of several branches of the Forest Service's Southern Forest Experiment Station, New Orleans, La., but it will be augmented and strengthened by access to the university's forest, library, and laboratories, as well as by the availability of faculty members with special skills and knowledge.

■ The Ohio State University College of Medicine has become the first civilian institution to offer graduate training in aviation medicine. A 3-year program has just been established in the department of preventive medicine that is open only to medical graduates who have completed their internship. A similar program will be instituted at Harvard University in September.

■ Former President Herbert Hoover has announced the establishment of a $42 million Stanford Medical Center Fund, which initially will raise $21,950,000. The fund is an organized effort by civic leaders, alumni, and Stanford University to finance the Stanford Medical Center. The project involves construction of buildings to permit consolidation of the School of Medicine on the university campus at Palo Alto, as well as modernization of Stanford Hospital facilities in San Francisco with a view to their eventual use in supplemental medical education and research. Hoover, a Stanford alumnus and a trustee of the university since 1912, is honorary chairman of the new organization.

■ The Manufacturing Chemists Association plans to spend $1 million in the next 5 years in carrying out a program designed to attract more American youths into scientific and engineering careers. During the coming school year, printed matter and visual aids will be provided for students and teachers in 3600 junior high schools, and a pilot program will be begun in senior high schools. This program will later be extended to the 11,700 high schools that offer chemistry courses and is expected to reach about 400,000 students. Next year a start will be made in attempting to interest sixth-graders in science by emphasizing the significance of science in daily life.

■ A new course in practical English for foreign physicians will be offered during the 1956 autumn semester at New York University's division of general education. The course is open to doctors, interns, and hospital administrators whose native tongue is not English. Particular emphasis will be given to vocabulary commonly used in medical histories, consultations, evaluations, case reports, progress notes, and patient interviews.

There has been a sharp increase in the number of foreign doctors in the United States. At present, more than 30 percent of all house staff physicians in New York, Ohio, and Illinois are aliens, and in New Jersey the figure is 69 percent.

■ The Polytechnic Institute of Brooklyn has begun the conversion of the $2 million industrial plant that it purchased in 1954 for a modern center of scientific and engineering education. The eight-story industrial structures and five-story administration buildings will house Polytechnic's 6000 students and $2 million research program. The institute's facilities are now scattered throughout downtown Brooklyn at 15 locations. It is hoped that the new quarters will be ready for use in September 1957.

Most of the 83 laboratories in the new building will be enlarged, more adequate versions of present facilities, and the increase in the amount of classroom space by more than 35 percent should permit an enrollment increase of one-third or more in the institute's day and evening sessions.

■ The Navy has begun construction of a $2 million guided missile school at the Dam Neck Fleet Air Defense School, Norfolk, Va. The school, to be called the Navy Guided Missile School, will

serve as the principal missile training center for the Atlantic coast area. Its curriculum will include all phases of missile operation as well as maintenance and repair of missiles. Construction is scheduled for completion by June of next year.

■ Yale University's Faculty of Arts and Sciences has been subdivided into the three general areas of the Humanities, the Sciences, and the Social Sciences. The new administrative grouping replaces the former University Division of Liberal Arts and the University Division of Sciences. Each division will have its own director. John G. Kirkwood, Sterling professor of chemistry, has been named director of sciences, and Kent T. Healy, Thomas DeWitt Cuyler professor of transportation, is director of social sciences.

■ The Department of Agriculture and Iowa State College have announced that a 318-acre tract of farmland just east of Ames, Ia., has been selected as the site for a new Federal livestock and poultry disease laboratory. The tract will be purchased by the state, which will later transfer title to the land without charge to the USDA. Funds totalling $16.25 million for construction of the laboratory were included in an appropriation bill signed by the President on 27 July.

USDA's Agricultural Research Service technicians will participate in the planning of the facility, which will be carried out under government contract, and will be responsible for its subsequent operation. Construction is not expected to begin until the summer of 1957.

Grants, Fellowships, and Awards

■ The earth sciences program of the National Science Foundation is now receiving applications for research grants to be made in the first 6 months of 1957. Deadline dates for proposals will be *1 Oct. 1956* and *8 Feb. 1957*. Applications received before 1 Oct. will be considered for grants to be awarded in February; those received by 8 Feb. will be considered for grants to be awarded in June. Applicants are urged to submit their proposals as far in advance of the deadlines as is practical.

■ Awards for study in statistics by persons whose primary field is not statistics but one of the physical, biological, or social sciences to which statistics can be applied are offered by the Committee on Statistics of the University of Chicago. The awards range from $3600 to $5000 on the basis of an 11-month residence. The closing date for application for the academic year 1957–58 is *15 Feb 1957*. Further information may be obtained from the Committee on Statistics, Eckhart Hall, University of Chicago, Chicago 37, Ill.

■ Four 1-year predoctoral scholarships of $1500 each will be offered annually to graduate students in their first year's work toward a Ph.D. degree in the basic sciences departments of New York University College of Medicine. Funds were provided by an institutional grant from the Commonwealth Fund. Selection will be made by a special faculty committee and application may be made, upon applying for registration as a predoctoral student, in September 1956 and thereafter.

■ The James Picker Foundation has announced the award of seven grants, three fellowships, and one grant for a scholar in radiological research for the coming year. These awards, totaling approximately $52,000, were made on recommendation of the committee on radiology of the National Academy of Sciences–National Research Council.

In the Laboratories

■ The Fischer and Porter Company, Hatboro, Pa., recently held dedication ceremonies for its new fluids calibration laboratory. The facility is called the Allan P. Colburn Memorial Flow Laboratory in honor of the late Prof. Colburn, one of the pioneers in fluids engineering research.

■ The General Electric Company has announced the establishment of a computer engineering laboratory at Menlo Park, Calif. To be known as the Erma Systems Laboratory, the new unit will be housed at the Stanford Research Institute. George Jacobi, a specialist in computers at the G.E. plant in Schenectady, N.Y., has been named manager of the California laboratory.

■ Walter H. Zinn, former director of Argonne National Laboratory and a pioneer in atomic reactor development, has announced the formation of a new company, the General Nuclear Engineering Corporation. Zinn is president of the firm, which is at Dunedin, Fla., in the St. Petersburg-Tampa area. The principal financing of the new organization is being provided by certain partners, acting as individuals, of the brokerage firm of Merrill Lynch, Pierce, Fenner and Beane.

■ Texas Instruments Incorporated, electronics and geophysics firm in Dallas, Tex., has acquired the William I. Mann Company, Monrovia, Calif., which employs about 100 persons in the manufacture of precision spherical and prismatic optical components. The Mann facilities complement Texas Instruments' work in cylindrical optical components, now conducted at its instrumentation subsidiary, Houston Technical Laboratories.

Miscellaneous

■ The Council of Biological and Medical Abstracts Ltd. has decided to change the title of its journal, *British Abstracts of Medical Sciences,* to *International Abstracts of Biological Sciences.* This decision results from two major developments. The first is an extension of coverage to a wider range of biological research subjects published in journals thr ughout the world, and the second is that the *International Abstracts of Biological Sciences,* with the cooperation of the specialist editors selected by the Institute of Scientific Information of the Academy of Sciences of the U.S.S.R., will include, as from the January 1957 issue, translations of the important Soviet papers abstracted in the *Referativny Zhurnal Biologii* and *Referativny Zhurnal Biologicheskoi Khimii,* to be published simultaneously with their appearance in Russian.

International Abstracts is published for the Council of Biological and Medical Abstracts Ltd. by Pergamon Press, London and New York, on a nonprofit basis. On the council are represented: the Association for the Study of Animal Behaviour, the Biochemical Society, the Association of Clinical Pathologists, the International Association for Dental Research, the Society for Endocrinology, the Society for Experimental Biology, the Nutrition Society, the Pharmacological Society, and the Physiological Society.

Since the Russian-language abstracts will have to be translated, the council requires translators and would welcome offers of help. Terms of payment and other details may be obtained from the honorary editor: Dr. C. C. N. Vass, c/o Pergamon Press Ltd., 4 and 5, Fitzroy Square, London, W.1, or 122 E. 55 St., New York 22, N.Y.

■ Articles included in the September issue of *The Scientific Monthly* are "Radiochemistry," Willard F. Libby; "Cattle raising: a way of life in the Venezuelan llanos," C. Langdon White; "Pseudonyms of physicists," Robert Lagemann; "Features of the solar spectrum as imposed by the physics of the sun," Richard N. Thomas; "Michael Faraday's researches in spiritualism"; and "Historical and thematic relations of psychology to other sciences," the late Egon Brunswik. In this issue five books are reviewed.

Reports

Effect of Starvation on Sperm Count and Sexual Reflexes

The relationship between the state of nutrition and sexual fertility is quite controversial. Huxley (*1*), Mason (*2*), Rommer (*3*), and Henshaw (*4*) maintain that good nutrition increases fertility, while Doubleday (*5*), Reid (*6*), and De Castro (*7*) claim that inanition increases fertility, as is suggested by Adam Smith's (*8*) observation that poverty favors generation. Jackson (*9*) reports that, although extreme famine inhibits libido and fertility, certain wild animals, such as the salmon, goose, and fur-seal, fast during the mating season, as does the penguin, as was observed by Sladen (*10*). Katcher (*11*) has noted that plants raised in inadequate soil produce more seed than plants grown in fertilized soil. In a recent exhibit, we (*12*) demonstrated that starvation is associated with an increase in sperm count.

In 13 male dogs, five failed to respond with ejaculation on genital stimulation. These animals were shy and evasive and were fearful when they were handled. Of the remaining eight animals, three had clear semen devoid of sperm, and in the other five sperms were present.

The semen was collected and measured during 1 minute of genital stimulation three times a week. In addition to the sperm count, the degree of erection and the latency and duration of enlargement of the bulbus cavernosus were observed. Two experiments involving 5 and 10 days of starvation, respectively, were carried out 1 year apart.

With 5 days of starvation, the weight loss was as follows for the animals named: Sampson, 3 lb; Choptank, 6 lb; English, 3 lb; and Poco 8 lb. Three dogs showed an increase in sperm count per cubic centimeter during the starvation period, and one, Poco, about 14 years old, showed aspermia prior to, as well as during, starvation.

With 10 days of starvation the dogs showed the following weight loss: Sampson, 2 lb; Choptank, 3.5 lb; English, 2 lb; and Poco, 8.5 lb. Within 3 days after the end of starvation, these dogs gained 3.5 lb, 5 lb, 5.5 lb, and 6 lb, respectively.

Table 1 records the sperm counts of the four dogs studied. There were individual differences. Sampson again showed the greatest variation in sperm count prior to the starvation period. During the starvation period the count rose considerably. Following the starvation period the sperm count fell again to about the original level. In this experiment Choptank showed relatively less fluctuation in the control sperm count than in the preceding one. During starvation, the count rose considerably. Following the period of starvation the sperm count remained elevated for 4 days and then declined. English showed prestarvation sperm counts comparable to those of Choptank. During starvation the count rose consistently. Following starvation it fell and then rose again. The fourth dog, Poco, showed the same paucity of sperm in the control observations as in the earlier experiment. During starvation the count rose this time to a phenomenal 866 million per cubic centimeter on the tenth day. Following starvation there was an abrupt fall in sperm count. The latter counts were still quite in excess of the control counts observed in this dog.

In addition to the effects on sperm count per cubic centimeter, the effect of starvation on total sperm count was determined (Table 1). Sampson, English, and Poco showed significant increases in absolute sperm count during starvation, with diminution of sperm count subsequent to the starvation period. In the case of Choptank, the total sperm count failed to show any increase during starvation, even though he showed a significant rise in sperm per cubic centimeter. This discrepancy is due to the smaller volume of fluid produced during the starvation peroid, thus giving a higher count per cubic centimeter.

There was no significant correlation between the sperm count, volume of seminal fluid, and the duration of bulbar enlargement.

A review of the studies of a number of investigators—Jackson (*9*), Reid (*6*), Siperstein (*13*), Stone (*14*), Musgrave (*15*), Dunn (*16*), Mason (*2*), Flipse (*17*), Holt and Albanese (*18*), Asdell (*19*), and Robinson (*20*)—revealed that inanition owing to limited diets generally inhibited reproduction. The effects were found to vary in different animal species. Although these experimental data are not in agreement with our observations, Gantt (*21*) observed that sexual conditional reflexes are not abolished by 5 days of starvation. This contradicts the inhibitory effects of inanition reported by others.

Although we are fully aware of the potential pitfalls involved in interpreting human behavior on the basis of data derived from other species, the sociological implications of our findings are evident. Russell (*22*) found that subfertile men had lower sperm counts (below 50 million per cubic centimeter) than fertile men. There was no correlation between lowered fertility and malnutrition. Russell makes reference to the high birth rate of the undernourished in India, and he suggests that emotional stress may play a role in male subfertility. From a broad, biological point of view, one might ask whether increased fertility during the early period of starvation could not be a

Table 1. Sperm counts in millions per cubic centimeter and total sperm per ejaculate during the prestarvation period (20 May–3 June), ten days of starvation (7–17 June), and the poststarvation period (18–25 June).

Date (1954)	Sampson		Choptank		English		Poco	
	Count	Total	Count	Total	Count	Total	Count	Total
20 May	954	1908	195	705	387	340	28	17
24 May	175	503	337	1209	227	539	26	3
27 May	257	610	250	906	314	706	0	0
3 June	231	319	363	1270	201	653	9	1
Starvation started 3 June, 5 P.M.								
7 June	410	922	369	1014	183	477	146	18
10 June	475	1187	438	1095	321	1043	33	4
17 June	632	1264	513	831	507	1333	866	216
Starvation discontinued 14 June, 4 P.M.								
18 June	590	1475	438	1038	281	953	171	32
21 June	344	774	320	719	241	322	325	25
25 June	350	787	332	747	492	826	134	8

compensatory process in the maintenance of species homeostasis, as is suggested by Doubleday (*5*).

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29 June 1956

Mobility of Calcium-45 after Injection into Western White Pine

Calcium is generally thought to be an immobile element in the plant (*1*), although a report of its redistribution in the peanut has been published (*2*). Williams, in a recent review of the literature on redistribution of minerals in plants (*3*), reported no instances of calcium mobility.

The use of calcium-45 in connection with other studies of mineral translocation in western white pine gave an unusual opportunity to study the mobility of this element (*4*). In 1951, 1952, 1953, and 1954, during July and August, trees of this species in various locations in northern Idaho were injected with solutions of calcium-45 in carrier solution. This was accomplished by attaching metal or tarpaper cups to the trees, sealing the junction between tree and cup, filling the cups with carrier solution, and then incising the tree with a wood chisel and hammer. At least 40 percent of the circumference was opened in this manner, with the chisel penetrating completely through the phloem and into the xylem about 1 to 1.5 in. The radioisotope solution was then pipetted into the carrier, mixed, and subsequently taken up by the tree with the carrier.

Trees of several sizes were used in the experiments. The Sands Creek, Three Mile Creek, and Clarkia Peak trees (Table 1) were all of pole size (50 to 70 years old and 65 to 90 ft tall), while the Hollywood trees were smaller, being 12 to 15 years old and 15 to 20 ft tall. The larger trees were injected with 1.25 to 3.78 mc of calcium-45 per tree, and the smaller trees received from 0.10 to 0.71 mc per tree. The carrier solution for the larger trees was introduced as a solution of 8 to 9 lit consisting of from 0.15 to 2 mole of Ca^{++}, 0.03 to 0.17 mole of K^{+}, 0.008 to 0.06 mole of NH_4^{+}, 0.32 to 2.5 mole of NO_3^{-}, and 0.002 to 0.02 mole of PO_4^{---}. The carrier solution for the smaller trees was introduced as approximately 0.5 lit of solution containing 0.04 to 0.4 mole of Ca^{++}, 0.03 to 0.04 mole of K^{+}, and 0.14 to 0.83 mole of NO_3^{-}. For both large and small trees, the solutions were made just acid to methyl red (*p*H 4 to 5) with HNO_3 and KOH.

Two weeks to a month after injection, the trees were climbed, and the foliage of the current year was sampled in various parts of the crown. The foliage samples were returned to the laboratory, dried at 70°C, and ground in a Wiley mill. A 2-g sample was then wet digested, the calcium was precipitated as the oxalate, and the precipitate was filtered off in small Buchner funnels and counted in a flow counter. Finally the precipitate was titrated to determine total calcium. The counts were corrected for coincidence, background, self absorption, half-life (to date of injection) and finally were expressed in counts per minute, per gram of dry tissue (70°C). These data are given in Table 1.

The year after injection, during the months of July, August, and September, most of the trees were climbed and sampled for the newly developed terminal and lateral buds. These buds were analyzed to determine whether they contained calcium-45; activity would indicate that the previously deposited calcium had moved into these tissues. These samples were analyzed as the foliage samples had been, and the results are given in Table 1. For a few trees it was possible to make a similar analysis of terminal and lateral buds developed and sampled 2 years after injection, and these are also listed in Table 1 for the trees for which data are available. For comparative purposes, it should be noted that the calcium activity in the buds is an appreciable percentage of the activity of the foliage accumulating calcium at the year of injection.

Data for one group of trees were calculated on a specific activity basis (counts per minute, per milligram of total calcium), and these are presented in Table 2. This calculation, which gives an estimate of the ratio of calcium-45 moving into the tissues compared with the total

Table 1. Calcium-45 activity in foliage and buds of western white pine at varying periods after injection.

Location of tree and year of injection	Counts/min g corrected to time of injection		
	Buds		Foliage
	1 yr. after injection	2 yr. after injection	In year of injection
1951, Sands Creek tree, No.			
1	41,400		86,000
2	27,300		92,000
3	46,300		48,000
1952, Sands Creek tree, No.			
4		17,400	3,900*
5		7,230	5,470*
6		2,410	5,180*
7		5,180	6,200*
1953, Hollwood tree, No.			
1	20,350	3,610	56,500
2	22,700	9,700	35,500
3	19,900	2,170	88,300
4	14,700	5,720	29,700
5	5,080	6,790	21,200
6	12,900	10,400	102,000
1954, Three-Mile Creek tree, No.			
1	16,100		59,000
2	36,100		13,710
3	2,680		4,920
1954, Clarkia Peak tree, No.			
1	6,600		13,240
2	4,410		4,800
3	15,730		31,400

* Foliage in year following injection.

Table 2. Specific activity (Ca^{45} counts per minute, per milligram of total Ca) in foliage and buds of western white pine at varying periods after injection.

Hollywood tree, No.	Counts/min mg total Ca corrected to time of injection		
	Buds		Foliage
	1 yr. after injection	2 yr. after injection	In year of injection
1	20,400	2210	8,940
2	22,700	5130	6,840
3	9,220	1270	16,900
4	12,200	3910	7,890
5	20,000	7900	5,300
6	11,300	7780	13,450

calcium there, makes the amount of calcium movement into the buds appear still more impressive. In most cases, on the specific activity basis, the 1-year-old buds have appreciably more calcium-45 in them than has the foliage on the tree shortly after injection.

These data, gathered from work during four different years and representing trees from four different areas, indicate that there was a substantial movement of previously deposited calcium into newly developed buds in this species.

The results indicate that calcium has considerably more mobility in western white pine than any previous reports would have led us to expect. We are conducting further investigations of this phenomenon.

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28 May 1956

Relationship of Hormone Dosage to Physiological Response

A traditional method for the presentation of the relationship between the response to a hormone and dosage is to plot the logarithm of the dose against response. Whereas this choice of coordinates is convenient when a wide range of dosage has been studied, it appears to lack theoretical foundation. It is the purpose of the present paper to suggest an alternative system of coordinates, which may find usefulness in certain situations.

This analysis is based on the fact that, whereas the physiological response to many endocrine products at low dosage levels is roughly proportional to dosage, an apparent saturation may often be achieved at high dosage levels, the response becoming asymptotic with respect to dosage. By analogy to the Michaelis-Menten concept that the abundance of enzyme-substrate complex limits the velocity of an enzyme-catalyzed reaction (*1*), it is suggested that the magnitude of a hormone-provoked response is limited by the abundance of hormone bound to appropriate sites on the target organ. Direct evidence for such binding is already at hand, in the case of insulin (*2*), as is the strong indication of approximate proportionality between the quantity of insulin bound by muscle and the physiological response, in this case, synthesis of extra glycogen (*3*).

Let Q equal the total number of sites for physiologically responsive attachment of hormone to a target organ, $[HT]$ equal the number of such sites occupied by hormone, and $[T]$ equal the number of sites not so occupied. Whence

$$Q = [HT] + [T] \qquad (1)$$

Assume the occurrence of a reversible reaction between circulating hormone H and target-organ acceptor sites,

$$HT \rightleftharpoons H + T$$

with an equilibrium constant given by the expression,

$$K = \frac{[H]\quad[T]}{[HT]} \qquad (2)$$

If the physiological response observed is now assumed to be proportional to $[HT]$, the abundance of target-organ sites occupied by hormone, then the maximal response will be observed when all available sites are so occupied:

$$Q = [HT] \qquad (3)$$

and half of maximal response will be observed when one-half of the sites are occupied and one-half are not so occupied, under which circumstances

$$[T] = [HT] = \tfrac{1}{2}Q \qquad (4)$$

If $[H]_{\frac{1}{2}}$ is defined as that concentration of circulating hormone necessary to provoke one-half of maximal response, then, from Eqs. 2 and 4,

$$K = [H]_{\frac{1}{2}} \qquad (5)$$

an expression which formally resembles that of Michaelis and Menten. From Eq. 2,

$$[T] = K\,\frac{[HT]}{[H]} \qquad (6)$$

and from Eq. 1,

$$[T] + [HT] = Q = K\,\frac{[HT]}{[H]} + [HT] \qquad (7)$$

whence

$$\frac{[H]}{[HT]}\,Q = K + [H] \qquad (8)$$

and

$$\frac{[H]}{[HT]} = \frac{K}{Q} + \frac{[H]}{Q} \qquad (9)$$

This transformation is analogous to that of Lineweaver and Burk (*4*), and the same expression (Eq. 9) may be reached from considerations resembling those of the Langmuir sorption isotherm (*5*).

If it may now be assumed that the concentration of unbound hormone $[H]$ is proportional to the dose administered, Eq. 9 may be employed as a basis for plotting of data. If dose/response is plotted against dose, a straight line should be secured with slope $1/Q$ and intercept (dose = 0) K/Q. In Fig. 1 is shown a sample of data selected from the literature showing fairly good linearity when the foregoing coordinates are employed. The data are those of Riddle and Bates relating dose of prolactin to increase in weight of the pigeon crop-sac (*6*).

The possible usefulness of this method of plotting is that, from measurement of slope and intercept, numbers may be obtained indicating the capacity of target organ to bind hormone Q and the affinity of hormone for such binding sites K^{-1}. Such numbers, of little meaning by themselves, may prove of interest in the study of responses to families of related hormones and of the altered responses to a hormone in the presence of antagonists, disease, and so on. A decrease in response to a hormone, may, on these coordinates, appear as an increase in the slope of the line, reflecting a decrease in Q, the total number of tissue sites available for binding. Alternatively, such a decrease in response may appear, when plotted, as a line of unchanged slope but with a higher intercept, indicating an altered affinity of hormone to tissue-binding site.

The linearity here observed can be anticipated only if the magnitude of the response is limited by the amount of bound hormone, all other necessary reagents for the response being present in excess. In some situations, such as the increased accrual of glycogen in rat diaphragm in response to insulin, this condition does not appear to have been fulfilled.

The results of the foregoing development have previously been briefly presented (*7*). During the preparation of

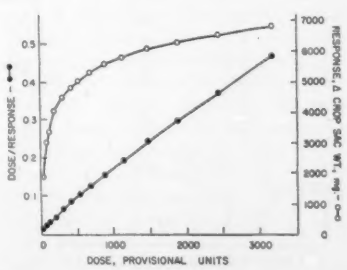

Fig. 1. Response, increase above control weight of crop-sac of a 450-g pigeon, plotted against dose of injected prolactin, in provisional units (open circles). The fraction, response/dose, plotted against dose (closed circles). Data are from Riddle and Bates (*6*).

the present report, a quite different analysis of the relationship of dose to response has been published (*8*).

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28 June 1956

Activity of Cerebral Neurons in the Transition from Wakefulness to Sleep

The transition from wakefulness to sleep—whether natural or induced by barbiturates—is accompanied by a change in the electric activity of the brain, which has been classically described as a passage from a "desynchronized" to a "synchronized" state. Recent studies of this change in electric activity, by means of microelectrodes (*1, 2*), have shown that it is related to the patterns of activity of cortical and thalamic neurons; synchronization is accompanied by a grouping, and desynchronization by a lack of grouping, of their action-potentials.

On the basis of the time, phase, and amplitude characteristics of the grouped action potentials, it has been inferred (*2*) that, in the synchronized state, some of the neurons of the diffuse thalamic projection system become active in a regular sequence, so that a wave of activity approaches, reaches, and goes beyond the tip of the recording microelectrode.

This report presents direct evidence, obtained by the use of paired microelectrodes, for the sequential character of the propagation of impulses during the synchronized state (*3*).

Experiments were performed in cats that had been anesthetized with Nembutal. Paired microelectrodes made of stainless steel were stereotaxically directed into the diffusely projecting nuclei of the thalamus, and the recording points were subsequently checked by histological control (*4*). Tracings were obtained through two identical amplification channels and a double-beam cathode-ray oscillograph (Fig. 1).

Figure 2*A–G* shows a series of groups of action potentials (from one complete spindle-burst *5*) recorded during the synchronized state from the center median of the thalamus, with a transversally directed pair of microelectrodes. In *A*, the activity reaches first the medial electrode and later the lateral electrode, indicating propagation in the lateral direction. In *B*, it reaches both electrodes at the same time, indicating propagation in a direction perpendicular to the plane of the electrodes. In *C*, it reaches first the lateral and later the medial electrode, indicating a reversal of propagation in the medial direction. In *D* and *E*, the amplitude of the action potentials increases considerably, indicating that the propagating wave of activity is now closer to the tips of the microelectrodes. In *F* and *G*, the wave of activity is again more distant and reverses its direction of propagation.

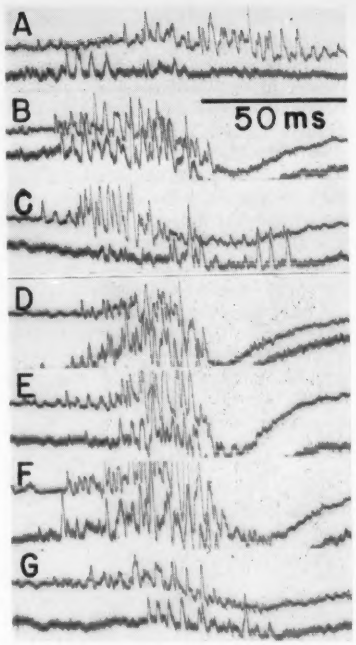

Fig. 2. Successive groups of action potentials (from a complete "spindle-burst" developing at 7 cy/sec) recorded from the center median, with one pair of microelectrodes, directed medio-laterally. Tips of microelectrodes 4 μ in diameter, 30 μ apart. Upper tracing in each strip is from the lateral electrode, lower tracing from the medial electrode. Amplifier time constant equals 0.2 sec. upward deflections are negative. Time between successive strips equals approximately 1/7 sec.

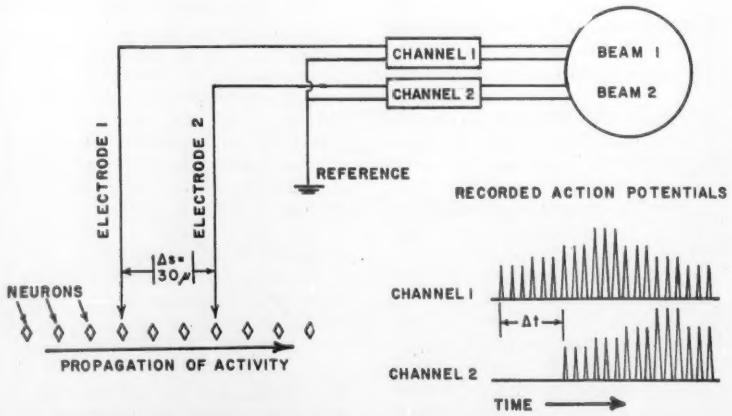

Fig. 1. Diagrammatic representation of the microelectrode, amplifier, and cathode-ray oscillograph arrangement and of the time relationships that should obtain between groups of action potentials recorded on two tracings, if activity is propagated in the direction of the arrow. ($\Delta s/\Delta t$ = velocity of propagation.)

Recordings obtained from other diffusely projecting nuclei, in other experiments, with pairs of microelectrodes separated by 30 to 100 μ, directed either in the medio-lateral or the antero-posterior plane, show very similar patterns of propagation. The following conclusions can be drawn from these observations.

1) The transition of the electric activity of the brain from the desynchronized to the synchronized state is related to the appearance, in the diffuse thalamic projection system, of waves of activity propagated sequentially from neuron to neuron.

2) The changes and reversals in the direction of propagation of the wave of activity (that is, from medio-lateral, to antero-posterior then to latero-medial, and so on) indicate that the latter goes

back and forth, through, and around the recording site, which suggests some kind of "reverberation," although the exact geometric pattern of the pathway and its dimensions could not be determined at this stage of the investigation.

3) Since the distance between the tips of the microelectrodes is known, the velocity of propagation can be estimated by measuring the time that the "wave-front" takes to travel from one tip to the other. It has been found in these experiments that the order of magnitude of the velocity of propagation is 0.5 to 5 mm/sec.

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4. It is a pleasure to acknowledge the assistance of Cora Rucker, department of anatomy, University of California, Los Angeles, in the preparation of the anatomical material.
5. *Spindle-bursts* is a term used in electroencephalography to designate the wave-trains of progressively increasing and decreasing amplitudes that characterize the appearance of the "synchronized" state.

4 June 1956

Selective Action of Pentobarbital on Component Behaviors of a Reinforcement Schedule

Dews (*1*) has shown that the effects of sodium pentobarbital on a learned response in pigeons depend critically on the schedule of reinforcement used to maintain the response. Behavior under a fixed-interval reinforcement schedule (that is, after a fixed period of time, the first occurrence of some arbitrarily selected response makes food accessible to the subject for a brief period) shows great sensitivity to sodium pentobarbital. Different subanesthetic dosages produce a variety of changes, including both a depressive and an excitatory effect. On the other hand, behavior under a fixed-ratio reinforcement schedule (that is, food is presented after every *n*th occurrence of the response) is resistant to the drug. With this schedule of reinforcement, dosages approaching the anesthetic level are required to produce any change in the rate of emission of the response under observation.

The differential reaction of differently maintained behavior to sodium pentobarbital is here further investigated (*2*).

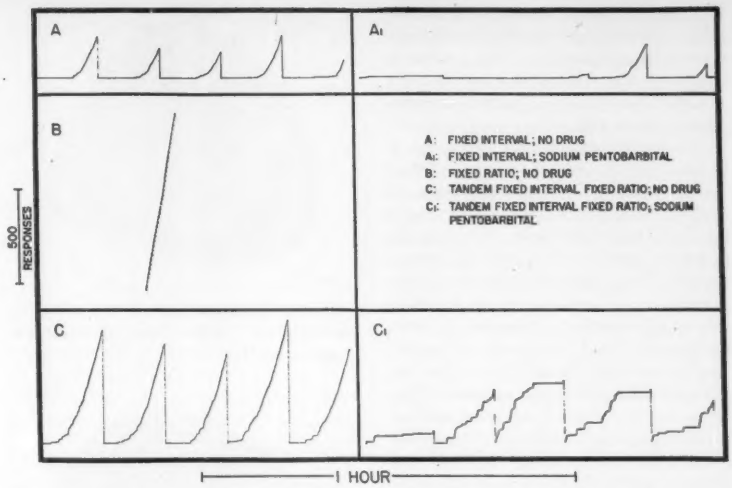

Fig. 1. Cumulative response curves showing the effects of sodium pentobarbital on behavior maintained by fixed-interval and tandem schedules of reinforcement.

Two food-deprived pigeons were used, and the response was pecking an illuminated disk. The reinforcement was brief access to food. The experimental apparatus has been described by Ferster (*3*).

The schedule of reinforcement used in this experiment is one that combines certain features of both fixed-interval and fixed-ratio schedules. The pigeon is reinforced after 10 min, but for the 13th response after 10 min, instead of the 1st response after 10 min (as in an ordinary 10-min fixed interval). This schedule is designated as a *tandem*: fixed interval of 10 min, fixed ratio of 12 responses (*4*).

The behavior resulting from the tandem schedule is similar to behavior under fixed-interval reinforcement, in that the animal's response rate increases as the end of the 10-min period approaches. The behavior shows the effect of the fixed-ratio component in the relatively high rates of response that occur.

Figure 1 shows sample cumulative records for fixed-interval, fixed-ratio, and tandem schedules of reinforcement, in *A*, *B*, and *C*, respectively. Cumulated number of responses is along the ordinate; time is along the abscissa. *A* shows a record for a 10-min fixed interval. Five successive 10-min intervals are shown. The pen is reset to the bottom of the record after each reinforcement. The typical characteristics of each fixed-interval performance are the initial period of no responding and the subsequent positive acceleration in the curve up to a terminal rate of about two responses per second. *B* shows records for a fixed ratio of 25 responses. The short diagonal strokes to the right of the record indicate reinforcements. The rate here is four to five responses per second and there are no pauses. In *C*, a sample record for a tandem (fixed interval of 10 min, fixed ratio of 12 responses) is shown. There are again five successive intervals, the pen being reset after each reinforcement. Although the performance here retains the positive curvature of the ordinary fixed interval, it can be seen that the over-all rate of response is much higher than in the ordinary fixed interval and that there is some tendency for short groups of responses at high rates to occur. Both of these differences from ordinary fixed-interval performance can be attributed to the presence in the tandem schedule of the small fixed-ratio component.

The effect on the fixed-interval performance of 2 mg of sodium pentobarbital, injected intramuscularly 5 min before the start of the record, is shown in *A*1. The effect is clearly one of depression, even though casual observation of the pigeon's general activity would not reveal any disturbance. The second interval in *A*1 contained only one response, the reset of the pen is therefore absent for this interval. The first and third intervals exemplify another frequently observed effect of pentobarbital, in addition to the depression. In these two intervals, the response curve did not show the positive acceleration that is typical of normal fixed-interval performance.

*C*1 shows the tandem performance 5 min after the intramuscular injection of 4 mg of sodium pentobarbital. The drug has again resulted in an over-all depression of responding. There is, in addition, no evidence of positive curvature in each interval and almost all low or intermediate rates of response have disappeared.

The 10-min period is now filled with groups of responses at high rates and periods of no response. This record is typical of others obtained after injection of sodium pentobarbital with a tandem-schedule base line.

The result obtained by Dews seems to be confirmed here by the use of a different experimental technique. Dews showed that the behavior maintained by fixed-ratio schedules was much more resistant to sodium pentobarbital than that maintained by fixed-interval schedules. In the present experiment, a tandem schedule was used, combining features of both fixed-interval and fixed-ratio schedules. The behavior generated by the tandem schedule shows both the progressive increase in rate typical of fixed-interval performance and the rapid responding characteristic of fixed-ratio performance. Sodium pentobarbital, by its selective interference with these two forms of responding, served to fractionate the tandem-schedule performance. Both effects of sodium pentobarbital on fixed-interval behavior were observed when the tandem schedule was the base line. There was both the depression in rate and the loss of positive curvature in the record. The rapid, fixed-ratio responding, which is insensitive to sodium pentobarbital when a fixed-ratio schedule alone is used as a base line, was not, however, disrupted by the drug. These findings serve the dual function of further substantiating the selective action of sodium pentobarbital and of being a demonstration of the presence of fixed-interval and fixed-ratio components within the tandem-schedule performance.

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22 June 1956

Fish Scales in a Sediment Core from Linsley Pond, Connecticut

During a study of the LV sediment profile (*1*) from Linsley Pond, Connecticut, two fish scales were found at depths of 25.0 and 24.2 m below the present water surface (10.2 and 11.0 m below the mud-water interface). The scales

Fig. 1. Fish scale from 24.2-m depth in sediment of Linsley Pond, Connecticut. (approximately × 22).

Fig. 2. Scale of golden shiner, *Notemigonus crysoleucas*. (approximately × 26).

were found in sediments of the lower Cl pollen zone. The radiocarbon dates for the upper and lower Cl pollen zones are 5200 and 8300 years, respectively, (*2*). The scales are therefore located in sediment that is approximately 7500 years old.

Following Lagler's key to scales of Great Lakes fishes (*3*), the older of the two scales (25.0-m depth) was identified plausibly by Vallentyne as a scale from a member of the family Cyprinodontidae, of which there is only the banded killifish, *Fundulus d. diaphanus*, in Connecticut's lakes now (where reportedly they are restricted to sandy-gravelly shoals (*4*). This scale was lost inadvertently.

A photograph (Fig. 1) of the younger scale (24.2-m depth) shows one apparent annulus; the fish was nearing its second birthday at least. The characteristics of this scale further indicate that it came from a member of the minnow family, Cyprinidae. The present-day native minnows of Connecticut are fallfish (*Semotilus corporalis*), creek chub (*Semotilus atromaculatus*), blacknose dace (*Rhinichthys atratulus*), common shiner (*Notropis cornutus*), cutlips minnow (*Exoglossum maxillingua*), bridled shiner (*Notropis bifrenatus*), golden shiner (*Notemigonus crysoleucas*), and spottail shiner (*Notropis hudsonius*) (*4*).

The find resembles "typical" scales of the last two of the foregoing and quite clearly of none of the rest. Comparison is made difficult by the facts that the Cl specimen is somewhat fragmented, that its central area (focus) is eroded (almost certainly it is a replacement scale and not one of the fish's original complement), and that there is variation in scale configuration and visible components from place to place on a fish. Identification as golden shiner (see Fig. 2), *Notemigonus crysoleucas*, is preferred to that as spottail, *Notropis hudsonius*, because of the small number and angles of the radii and on grounds of contemporary ecology. *Notemigonus* is the most common Connecticut lake minnow (*4*) —also predominantly lacustrine elsewhere in its range—although it is locally abundant in the Great Lakes. There is no evidence for concluding that the Cl cyprinid scale is from a species once but no longer extant in the pond drainage.

This appears to be the first instance in which single fish scales have been found in lake-sediment cores. The scales were encountered only by accident. A thorough and premeditated search for scales in lake sediments might provide data bearing on fish succession during lake history. Providing that the scales could be specifically identified, the information obtained would be of considerable interest to paleobiogeographers and limnologists alike. The presence of scales from cold stenothermal fishes would be of particular interest in relation to the obliteration of the hypolimnion as the lake basin filled in (*5*).

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23 July 1956

Correction

In our paper "Mitochondrial self-duplication observed *in vitro*" [*Science* 124, 123 (20 July 1956)], the authors of two of the references were incorrectly given. The authors for reference 5 are E. P. Kennedy and A. L. Lehninger; the authors for reference 6 are J. W. Harman and M. Feigelson.

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29 July 1956

Book Reviews

The Structure and Function of Skin. William Montagna. Academic Press, New York, 1956. 356 pp. Illus. $8.80.

In a relatively few, beautifully illustrated pages, William Montagna systematically describes the microscopic, submicroscopic, and histochemical anatomy of the many structures in the most extensive and multipotent organ in the body—the skin. This book presents an unusual three-dimensional view of the structure, and adds a fourth dimension of function, of the cutaneous system. A blending of biological and physiological information with detail on anatomy keeps the monograph from being merely a dry, reference volume.

The author's common-sense approach to the problem of excess terminology is seen in his proposal to retain the term *melanoblast* for both the immature and the more mature types of pigment-forming cells. He presents an unusually lucid comparison of melanoblasts and clear cells of Langerhans.

There is also a keen analysis of the secretion granules in apocrine sweat glands, in which the author questions the acceptance of this phenomenon as the sole index of secretory activity.

The text includes an excellent chapter on the terminology and architecture of the hair follicle and an analysis of its pattern of growth. Montagna emphasizes that it is still not known whether increase in vascularity of the follicular capillary system is a stimulus that causes resting follicles to become active or whether it is a response to a stimulus that originates within the follicle.

The author points out that, while seborrhea usually accompanies acne vulgaris, the sebaceous gland is only one of the elements of the cutaneous system and that the latter functions as a unit. The pathogenesis of acne may, therefore, involve dysfunction of the entire skin rather than overactivity of only one component.

Montagna, whose investigative acumen I appreciated when I functioned as executive secretary of the National Research Council's advisory group in the field of dermatology, is a member of the Subcommittee on the Cutaneous System of the National Academy of Sciences–National Research Council and has made important contributions to knowledge of the functional anatomy of the skin and its appendages. In Chapter VIII, entitled "Reflections," the author modestly puts his own philosophic interpretations last. I recommend that these be read upon beginning the volume; they are very worth while and add to the enjoyment of the text.

The book will be found highly interesting, not only by anatomists, histologists, and dermatologists, but also by pathologists, physiologists, biochemists, research workers, and all who are intrigued by the basic science of medicine.

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Pilot Plant Techniques of Submerged Fermentation. Special English edition of *Rendiconti Istituto Superiore di Sanita,* vol. 17. Fondazione Emanuele Paterno Viale Regina Elena, Rome, 1954 (distributed by Interscience, New York). x + 243 pp. Illus. Paper, $8.10.

This book is the first of a series of English editions of the *Journal of the Istituto Superiore Di Sanita* of Rome. It consists of papers originally published in Italian and covers much of the work on submerged fermentation equipment and techniques carried out in the International Research Center for Chemical Microbiology under the direction of E. B. Chain.

The first paper is a continuation of the excellent and complete studies of oxygen transfer which have been made under Chain's direction. The paper includes aeration studies in shake flasks, 10-liter, 50-liter, 130-liter, 200-liter, and 12,000-liter fermentors. In addition to the usual sulfite method for determination of oxygen transfer, a method using the rotating platinum electrode is described.

About one-half of the book is devoted to papers describing the design and operation of the equipment used at the institute for the submerged culture of aerobic organisms. This portion of the book will be of interest primarily to engineers and persons in charge of pilot-plant and production equipment. Such persons will benefit greatly from reading these chapters. This series of papers is written and illustrated in such detail that it should be possible for one completely unskilled in the operation of a submerged fermentation pilot plant to reproduce and operate such a pilot plant. Several new and novel techniques are included—for example, the bottom entering "compensated" stuffing box in which a portion of the stuffing box is completely submerged in the fermenting medium.

Several unsafe acts, at least by American standards, are described. It would be unthinkable in the United States to apply 0.5 atmosphere to an ordinary round-bottom flask, even though the flask is "wrapped in a towel to protect the operator against the danger of an explosion. . . ."

In addition to the aforementioned papers, two others are included in this section; one is a paper describing a rotary shaker suspended on steel balls, and the other is a study of methods used for the evaluation of antifoam preparations.

The paper on the study of the effect of mechanical agitation on the morphology of *Penicillium chrysogenum* is excellent; although it is near the end of the book, it should be read in conjunction with the paper on aeration. Two papers on heterokaryosis in *Penicillium chrysogenum,* a study of the interrelation of protein and polynucleotide synthesis in *Escherichia coli,* and a description of a new genus of soil fungus, *Romanoa,* are included

The book is paper bound and is rather fragile. The fairly large number of typographic errors do not significantly detract from its readability. This book should prove to be of interest and benefit to anyone interested in the subject of submerged fermentation, whether in research, production, or engineering. It is hoped that the other English editions of the journal of the institute will be forthcoming as planned.

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Gestation. Transactions of the second conference 8–10 Mar. 1955, Princeton, N.J. Claude A. Villee, Ed. Josiah Macy, Jr., Foundation, New York, 1956. 262 pp. 116 illus. $5.

The second conference on gestation was attended by 12 member participants and nine guests. Seven papers were presented as follows: "Self-regulatory functions during gestation and lactation" by Curt P. Richter, "Social reactions of

pregnant and lactating rats" by Pierre C. Karli, "Delayed implantation in mammals" by Robert K. Enders, "Morphology and physiology of the uteroplacental circulation" by James Dixon Boyd, "Uteroplacental circulation in mammals" by C. Sidney Burwell, "Pressures in the fetal circulatory system of the sheep" by S. R. M. Reynolds, "Distribution of arteries and veins in the mammalian placenta" by Elizabeth M. Ramsey.

These conferences are especially interesting, because there are interruptions throughout each presentation. Furthermore, the discussions are spirited, provocative and frank. As Fremont-Smith says, "the tradition, now well established, that authority carries little weight in evaluating the credibility of ideas, concepts, and data, help to make the conference a forum for searching examination of differences of opinion and of the reasons for contradictory experimental results. Overgeneralizations are quickly met with the question 'with respect to what?' "

The discussion of Boyd's paper concerning the uteroplacental circulation was particularly interesting to me, but it is unfair to select any of the papers presented as being more worthwhile than the rest.

The book is a very important contribution on the subject of gestation. It is up-to-date and contains a vast amount of valuable information presented by experts in anatomy, biological chemistry, physiology, cancer, biology, psychobiology, zoology, embryology, and obstetrics and gynecology. It is a pleasure to read the book, not only for its stimulating contents, but also because the type is clear and the illustrations are well reproduced.

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Expanding Universes. E. Schrödinger. Cambridge University Press, Cambridge, 1956. 93 pp. 10 illus. $3.50.

This lucid series of lectures is concerned with the kinematics of particles and waves in an expanding universe. The first two chapters present an interesting exposition of the geometric properties of the de Sitter universe and general spherical spaces. Various representations of the de Sitter universe are compared. Properties of the geodesics and null geodesics and the meaning of the red shift of light waves are discussed. The other two chapters deal with a question that led historically to the development of wave mechanics—that is, the relationship between geometric optics, wave optics, and the Hamilton-Jacobi equation. The propagation of waves in an expanding universe and the concept of paths along geodesics are examined. The discussion follows largely some research work of the author that was published in the 1930's.

The book is distinguished throughout by its delightful clarity, its constant emphasis on geometric visualization and its unhurried style. This forms a pleasant contrast to the modern tendency of piling formalism on formalism, and one cannot help wondering whether our contact with physical intuition is not seriously obstructed by the modern trend in the style of writing.

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Engineering in History. Richard S. Kirby, Sidney Withington, Arthur B. Darling, and Frederick G. Kilgour. McGraw-Hill, New York, 1956. vii + 530 pp. Illus. $8.50.

History of American Technology. John W. Oliver. Ronald Press, New York, 1956. $6.50.

The stimulating history of engineering by Richard S. Kirby and his associates emphasizes at all times the close contacts between science and engineering. The initiation of novelty emerges, at times, in some practical application for which scientific analysis finally affords a generalized explanation, as in the case of the suction pump; at times, applications emerge from the prior establishment of a general principle, as Boyle's law led to an efficient use of steam. Keen perception of this association between science and engineering has made it possible for the authors to compress into a single volume an impressive history of the fields of civil engineering, construction, transportation, and power engineering.

The short chapters on Egypt, Greece, and Rome emphasize the dependence of ancient engineering on massed human labor, despite the emergence of two types of water wheel toward the close of the pre-Christian era. The generalized use of water and wind mills in the Middle Ages is characterized as a revolution in power, which laid the foundations of a new economy. The development of science, beginning with Leonardo da Vinci, freed engineering from the limitations of mere empiricism in the use of pressure media, making possible a further advance in the power economy.

The development of stone work is covered step by step from the Roman arch through the Gothic. In bridge design, the use of wood led to truss designs as early as Palladio, and this innovation, of course, came to have special significance when iron and steel became available. The history of steam transportation on land and water is remarkable for its compactness and comprehensiveness. The outstanding features of the later chapters are the account of the electric industries, the techniques of caisson work, tunneling shields, and suspension bridges.

Despite the wide range of material, the narrative has a structure that is vividly felt and moves with such vigor that it is hard to lay the book down. It is a fine achievement in historical writing.

The study of American technology by John W. Oliver is unusual because of the emphasis on the intimate relationships between science, technology, and culture. Although new discoveries in science and major inventions are fully appreciated, much attention is given to the diffusion of scientific and technical knowledge by scientific societies and to modifications of engineering practice. The narrative is divided into four periods: 1607–1789, 1789–1865, 1865–1900, and 1900 to the present. For each period, the technical features of production and communication are surveyed comprehensively. Agriculture and the processing of agricultural products is, therefore, an integral part of the narrative. Communication, too, is broadly conceived; it includes the development of the newspaper, printing, paper-making, and the whole sequence of electric inventions for the transmission of news and pictorial material.

Although all the topics in each period are fully covered, the arrangement is not stereotyped; hence, the characteristic problems of the different periods are not obscured by a rigid plan.

The development of the economy of the United States is portrayed with great skill and without undue emphasis on any single factor. The book is a notable contribution to the economic and cultural history of the United States and will be invaluable to the general reader and to college students.

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Yellow Fever Vaccination. World Health Organization Monograph Series, No. 30. World Health Organization, Geneva, 1956 (order from Columbia University Press, New York 27). 238 pp. Illus. $5.

In the story of the evolution and practical application of knowledge concerning yellow fever, the subject of vaccination is an important chapter and is very competently discussed in this monograph. An initial section by Smithburn sets the stage for the more technical sections that follow by reviewing the general question of the immunology of yellow fever. Appropriately, he considers in some detail serological methods for demonstrating

immunity but, unfortunately, at the same time he perpetuates a long-standing error of nomenclature by using the term *protection test* in reference to the demonstration of *in vitro* neutralization of virus by antibody. Apparently, this usage stems from the earliest tests for humoral antibody in which monkeys were protected by antiserum given separately from the virus.

The evolution, preparation, and use of yellow fever vaccines, of which there are two importantly different types, is then described. Durieux from the Pasteur Institute in Dakar, alone and with Koerber, speaks for vaccine made with the mouse-fixed French neurotropic strain of virus. Evidence is presented for excellent sero-immune response to such vaccine administered by scarification (often combined with vaccinia) and for satisfactory persistence of immunity with 82 percent or more of positive serums 7 to 12 years later.

Production and use of the less neurotropic 17D virus, grown in the chick embryo, in Brazil is described by Penna. For anyone concerned with mass application of injected vaccines, the detailed lists of equipment for field use should be of interest. G. W. A. Dick then describes the use of 17D vaccine by scarification with attendant advantages of simplicity and reduced cost of application. Curtois discusses immunity following 17D virus, citing evidence for its onset within 10 days and persistence for as long as 12 years; however, he quotes inaccurately from my own published work, particularly in discussing the possible relation of age to response and persistence of immunity.

Mass application of both types of vaccine is then considered. According to Durieux, 56 million vaccinations with Dakar vaccine had been made through 1954 in a French African population of about 25 million, accompanied by near elimination of reported cases of yellow fever. Manso reports on 22 million vaccinations with 17D virus in Brazil through 1954 and with no adverse effects since 1941 but is unable to muster data to show a decline in yellow fever morbidity, presumably because man is not involved in the jungle cycle of virus spread.

The longest section, by Stuart, considers the controversial question of postvaccination reactions. Excluding allergic reactions and the serum hepatitis resulting from the now discontinued practice of incorporating "normal" human serum in the 17D vaccine, chief interest relates to the delayed, encephalitic reactions owing to the vaccine virus. For 17D virus this problem, never very serious, was resolved by choosing on the basis of a field trial a substrain of minimal encephalitogenic potential and "freezing" it at the passage level tested. However, recent reports suggest that in infants under 1 year of age encephalitis may still be induced. As for the Dakar vaccine, all agree on the hazard of using it in persons under 2 years of age. However, whereas encephalitis is rarely reported from French Africa, the same vaccine in Nigeria and Costa Rica gave rise to an alarming incidence with a high case fatality.

In final sections by Bonnel, international regulations are discussed, and a very excellent selected bibliography is presented.

All told, this monograph is a definitive presentation of the general and technical aspects of yellow-fever vaccination. It should interest the worker and teacher in microbiology and everyone concerned with problems of local and international public health.

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New Books

The Hardiness of Plants. J. Levitt. Academic Press, New York, 1956. 278 pp. $7.

Alcoholism as a Medical Problem. A conference held under the auspices of the Committee on Public Health of the New York Academy of Medicine and the New York State Mental Health Commission. H. D. Kruse, Ed. Hoeber-Harper, New York, 1956. 102 pp. $3.

Ultraviolet and Visible Absorption Spectra, Index for 1930–1954. Herbert M. Hershenson. Academic Press, New York, 1956. 205 pp. $10.

Gmelins Handbuch der Anorganischen Chemie. No. 28, *Calcium* (Technology), pt. B, sec. 1, 264 pp., DM. 147; No. 44, *Thorium and Isotopes,* 406 pp., $55.68; No. 60, *Copper,* pt. A, sec. 1, 710 pp., $92.85; No. 60, *Copper,* pt. A, sec. 2, 755 pp., $101.04. Edited by Gmelin Institute. Verlag Chemie, Weinheim, West Germany, ed. 8, 1955.

Physics and Chemistry of the Earth. vol. 1. L. H. Ahrens, Kalervo Rankama, S. K. Runcorn, Eds. McGraw-Hill, New York; Pergamon, London, 1956. 317 pp. $8.

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Cryptococcosis. Torulosis or European Blastomycosis. M. L. Littman and Lorenz E. Zimmerman. Grune & Stratton, New York–London, 1956. 205 pp. $8.50.

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Insects and Spiders. A book of keys with biological notes. C. P. Friedlander and D. A. Priest. Philosophical Library, New York, 1956. 124 pp. $2.75.

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Miscellaneous Publications

(Inquiries concerning these publications should be addressed, not to Science, *but to the publisher or agency sponsoring the publication.)*

Electron Physics Tables. L. Marton, C. Marton, and W. G. Hall. NBS Circ. 571. (Supersedes pt. II of Mathematical Table 17.) National Bureau of Standards, Washington, D.C., 1956 (order from Supt. of Documents, GPO, Washington 25). 83 pp. $0.50.

Report of the Second Technical Meeting on Cooperatives in the Caribbean. Held at Georgetown, British Guiana 24–31 Jan. 1956. Food and Agriculture Organization of the United Nations, Rome, Italy, and Caribbean Commission, Port-of-Spain, Trinidad, 1956. 22 pp.

Patents on Light Weight Ceramics. Bull. of the Virginia Polytechnic Institute Engineering Expt. Sta. Ser. No. 111. Compiled and edited by A. J. Metzger. Virginia Polytechnic Institute, Blacksburg, Va., 1956. 69 pp. $0.25.

ASTM Standards on Metallic Electrical Conductors. Copper and copper alloys, copper-covered steel, aluminum, iron and steel. Sponsored by ASTM Committee B-1 on Wires for Electrical Conductors. American Society for Testing Materials, Philadelphia, 1956. 298 pp. $3.50.

Teaching by Closed-Circuit Television. Report of a conference sponsored jointly by the Committee on Television of the American Council on Education and State University of Iowa. Iowa Continuation Center, Iowa City, 26–28 Feb. 1956. American Council on Education, Washington, D.C., 1956. 66 pp.

The Mutants of Drosophila Melanogaster Classified according to Body Parts Affected. Norma B. Braver. Carnegie Institution of Washington, Washington, D.C., 1956. 36 pp.

Spring Lake Archeology, the Lee Mill Cave. Science Bull. No. 3, pt. 2. Elden Johnson and Philip S. Taylor. Science Museum of the St. Paul Institute, St. Paul 3, Minn., 1956. 31 pp. $1.

American Society of Civil Engineers, Directory 1956. Membership lists as of 15 Mar. 1956. American Society of Civil Engineers, New York 18, 1956. 797 pp.

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Colloque sur la Théorie des Nombres. Held at Brussels 19–21 Dec. 1955. Centre Belge de Recherches Mathématiques. Georges Thone, Liège; Masson, Paris, 1956. 204 pp. F. 2400.

Soil-Testing Methods. Moisture, density, classification soil-cement. Highway Research Board Bull. 122. 47 pp. $0.90. *Bituminous Resurfacing.* Highway Research Board Bull. 123. 39 pp. $0.75. National Academy of Sciences–National Research Council, Washington, D.C., 1956.

Planning for Progress. American Institute for Research Pittsburgh, Pa., and Washington, D.C., 1956. 44 pp.

Education in Taiwan (Formosa). Bull. 1956, No. 3. Abul H. K. Sassani. U.S. Office of Education, Washington, D.C., 1956 (order from Supt. of Documents, GPO, Washington 25, D.C.) 34 pp. $0.20.

Meetings and Societies

Friends of the Pleistocene

The 20th annual reunion of the Friends of the Pleistocene was held 26–27 May at Drummondville, Quebec, Canada. The meeting was conducted by Nelson R. Gadd, assisted by Jaan Terasmae.

A limited number of excellent exposures along the St. Francis, Nicolet, and Bécancour rivers were used to illustrate the known glacial and postglacial history of the central part of the St. Lawrence lowlands. The area was glaciated twice.

The first glaciation, represented locally by coarse, sandy, dark-red till, was followed by a fresh-water lacustrine period during which was deposited a thick sequence of varves. Extensive stream erosion then established a drainage system that would appear to be very similar to the present St. Lawrence drainage system. In some areas erosion removed all the varves and laid "old" gravels, derived from local bedrock on eroded surfaces of the red till and of the bedrock.

In a late stage of this erosion cycle, fine-to-medium sands were deposited in aggrading streams, and peat accumulated in abandoned channels that parallel the St. Lawrence and its larger tributaries. At one of the field-trip stops, upstream from Pierreville on the east bank of the St. Francis river, the group examined a buried peat bed from which the compressed peat of Y-256 (greater than 29,630 C^{14} years) was taken. In some sections, the group observed evidence of a readvance of the ice, following immediately at the close of the interglacial(?) interval, in the form of grey varves overridden by grey till. This upper grey till, younger than materials dated at greater than 29,630 years (Y-256) and greater than 40,000 years (W-189), is the only representative of the Wisconsin(?) glaciation.

In most sections the grey till is overlain directly by deep-water facies of the Champlain Sea deposits, but evidence was seen along the St. Francis River of a possible short-lived fresh-water interval following the second glaciation but just prior to the very rapid inundation of the region by waters of the Champlain Sea. A single marine episode was apparently followed by a regular and relatively rapid uplift and transition from the marine conditions of the Champlain Sea to the present fluvial system of the St. Lawrence.

One of the features of the trip was a visit to the Nicolet landslide that caused millions of dollars' worth of property damage and the loss of three lives on 12 Nov. 1955. Jacques Béland (Department of Mines, Quebec) gave the group an interesting résumé of his findings on examination of the slide area for his department. Also, during the trip, T. H. Clark (McGill University) enlightened the group on the significance of "Logan's Line" at an outcrop on the Nicolet River at Ste. Brigitte des Saults.

Seventy-five people in attendance at the dinner meeting were officially greeted on behalf of the Geological Survey of Canada by its chief geologist, C. S. Lord. R. F. Flint, chairman of the dinner meeting, reviewed current activities in the field of Pleistocene geology and then introduced Gadd, who briefly reviewed the Pleistocene stratigraphy of the region and commented on some of the problems of correlation. The second speaker, Terasmae, gave his view, based on palynological studies and on radiocarbon dates, that the "interglacial" interval represented by buried peats was most probably late Sangamon. Paul MacClintock was final speaker for the evening and brought up-to-date knowledge of his findings in the New York section of the St. Lawrence Seaway.

NELSON R. GADD
Geological Survey of Canada, Ottawa, Ontario

Meeting Notes

■ Leading American and British experts on atomic energy are to participate in the panel discussions on "Atomic energy in economic development" that will take place during the 1956 annual meeting of the World Bank in Washington, D.C. Lewis L. Strauss, chairman, U.S. Atomic Energy Commission, and Edwin Plowden, chairman of the U.K. Atomic Energy Authority, will take part in the discussion. Other members of the panel will be John Cockcroft, director, Atomic Energy Research Establishment, Harwell, and Willard K. Davis, director, Division of Reactor Development, U.S. Atomic Energy Commission. Corbin Allardice, adviser on atomic energy to the World Bank, will act as moderator.

The panel discussion will take place on the morning of 27 Sept. in the Sheraton-Park Hotel. The 11th annual meeting of the World Bank is being held there this year, 24–28 Sept., and will be attended by governmental and banking representatives from the 58 member countries of the bank.

The panel discussion, will center around an appraisal of the present stage of development of nuclear power reactors, with particular emphasis on factors affecting their economic utilization. United States and United Kingdom government policies and programs to assist the development and operation of nuclear power reactors in other countries will be discussed, including arrangements for the supply of enriched uranium and plutonium, and the reprocessing of these fuel elements.

Interest in the potentialities of nuclear energy on the part of the World Bank springs from the bank's interest in power development in its member countries. The present evidence that nuclear power stations can be operated on competitive terms with thermal stations in certain circumstances, together with the shortage of conventional fuels in many of the bank's member countries, leads the bank to keep closely in touch with nuclear possibilities. One of the results to be expected from the panel discussion will be a greater awareness of the upper and lower limits within which nuclear power can best be exploited. The panel discussion will be open to the public.

■ The climax of the Perkin Centennial, which is under the sponsorship of the American Association of Textile Chemists and Colorists with the participation of 27 technical, chemical, and scientific societies and two U.S. Government departments, will occur during the week of 10 Sept. at the Waldorf-Astoria Hotel in New York. Highlighting the week will be the presentation of more than 60 papers by specialists in various aspects of the field of dyes and colors, many of whom will also act as moderators or participants in panel discussions. The opening day of the program will be International Day, sponsored by the American Standards Association and International Organization for Standardization. Speakers from Canada, England, France, Germany, Switzerland, and the United States will be heard. Robert Robinson, internationally known chemist and chairman of the British Centenary, will be a luncheon speaker and will talk on "Sir William Perkin—his life and works."

The Olney medal award luncheon will

be held on Thursday, the recipient being Walter J. Hamburger of the Fabric Research Laboratories, Boston, Mass. The Perkin medal of the American Section of the Society of Chemical Industry will be presented to Edgar C. Britton of the Dow Chemical Company following the Perkin medal award banquet on 14 Sept. All of the papers presented at the centennial will be published in a volume of proceedings that will be sent to all general registrants.

■ Construction work on the new Plum Island Animal Disease Laboratory building of the Department of Agriculture is now nearing completion and its dedication will take place during the week of 24–28 Sept. Present plans are for a limited number of invited representatives of local organizations in the Plum Island area to visit the island on 24 Sept. On 25 Sept. representatives of the press, radio, and TV and of various livestock interests will be given an opportunity to see the new building and other installations.

The USDA will need to know ahead of time who will want to attend on this day, so advance registrations are requested. Groups visiting the laboratory necessarily must be kept as small as possible, and therefore each organization will be limited to one representative. Overnight accommodations on outer Long Island are limited.

The general public is invited to attend the ceremonies on dedication day, which is 26 Sept. The last 2 days of the dedication week have been set aside for a technical symposium on virus diseases for scientists working in this field. Attendance will be by invitation only, since housing and other facilities on the island can accommodate only a small meeting.

A kit of information about the Plum Island laboratory is being assembled by the information division of the Agricultural Research Service and will be available on about 1 Sept. from the Office of Information, U.S. Department of Agriculture. After dedication week the Plum Island Laboratory again will be closed to visitors, and will resume its work on fundamental research on foot-and-mouth and other foreign infectious diseases.

■ The Atomic Energy Commission will sponsor a conference on engineering education and nuclear energy for college and university presidents and deans of engineering at Gatlinburg, Tenn., 5–8 Sept. Presidents and deans of engineering of 150 colleges and universities having accredited engineering courses have been invited. Willard F. Libby, member of the commission, will address the conference at a dinner meeting on 6 Sept.

The purpose of the conference, which was suggested by the American Society of Engineering Education, is to provide an opportunity for college and university administrators to discuss programs of education and training for science and engineering students who are planning nuclear energy careers. The program will include presentations and discussions of recent developments in engineering education in nuclear energy, of anticipated needs for personnel trained in this field, and of the commission's educational and training program in nuclear energy technology.

Conference speakers will include members of the staffs of the Atomic Energy Commission and its national laboratories, and representatives of private industry and educational institutions. The program includes a tour on 7 Sept. of the Oak Ridge Institute of Nuclear Studies at Oak Ridge and the unclassified facilities of the Oak Ridge National Laboratory.

■ The fall general meeting of the American Institute of Electrical Engineers, which will be held in the Morrison Hotel, Chicago, 1–5 Oct., will observe the 100th birthday of Tesla, inventor of the alternating current electric motor and many other electric apparatus. The meeting will also observe the 80th birthday of Charles F. Kettering, a director and former vice president of General Motors Company, and inventor of the self-starter and lighting and ignition systems for automobiles. In addition, F. E. Terman, who is provost of Stanford University and dean of the School of Engineering, will be the first recipient of the AIEE Members-for-Life Fund medal in engineering education.

Society Elections

■ American Electroencephalographic Society: pres., John R. Knott, Psychopathic Hospital, Iowa City, Ia.; pres.-elect, Robert S. Dow, Portland, Ore.; sec., J. K. Merlis, 150 S. Huntington Ave., Boston 30, Mass.; treas., Peter Kellaway, Baylor University, Houston, Tex.

■ Society for Nondestructive Testing: pres., Richard F. Holste, General Electric Company, Milwaukee, Wis.; v. pres., Charles H. Hastings, Watertown Arsenal, Watertown, Mass.; treas., Maurice J. Curtis, U. S. Naval Ordnance Test Station, China Lake, Calif.; sec., Philip D. Johnson, 1109 Hinman Ave., Evanston, Ill.

■ Tissue Culture Association: pres., Philip R. White, Jackson Memorial Laboratory; v. pres., Joseph F. Morgan, Department of National Health and Welfare, Ottawa; sec.-treas., Duncan C. Hetherington, Duke University School of Medicine, Durham, N.C.

■ American Society for Metals: pres., Donald S. Clark, California Institute of Technology; v. pres., G. M. Young, Aluminum Company of Canada, Ltd., Montreal; sec., W. H. Eisenman, 7301 Euclid Ave., Cleveland 3, Ohio; treas., C. H. Lorig, Battelle Memorial Institute, Columbus, Ohio.

Forthcoming Events

September

24–25. Industrial Electronics Symposium, 5th annual, Cleveland, Ohio. (C. F. Schunemann, Thompson Products, 2196 Clarkwood Rd., Cleveland 3.)

24–26. American Oil Chemists' Soc., Chicago, Ill. (Mrs. L. R. Hawkins, AOCS, 35 E. Wacker Drive, Chicago 1.)

24–26. Biochemistry of Lignin, 3rd round table, Appleton, Wis. (H. F. Lewis, Inst. of Paper Chemistry, Appleton.)

24–27. Science of Photography, international conf., Cologne, Germany. (W. Schürmeyer, Hohenstaufenring 48/54, Cologne.)

24–28. International Dairy Cong., 14th, Rome, Italy. (R. E. Hodgson, Dairy Husbandry Research Branch, U.S. Dept. of Agriculture, Beltsville, Md.)

24–29. International Scientific Film Assoc., 10th cong., Vienna, Austria. (Secretariat of Intern. Assoc., 38, Ave. des Ternes, Paris 17, France.)

25–27. Atomic Industrial Forum and Trade Fair, 3rd annual conf., Chicago, Ill. (C. Robbins, AIF, 260 Madison Ave., New York 16.)

25–28. American Roentgen Ray Soc., annual, Los Angeles, Calif. (B. R. Young, Germantown Hospital, Philadelphia 44, Pa.)

25–28. Assoc. of Iron and Steel Engineers, annual, Cleveland, Ohio. (Secretary, AISE, Empire Bldg., Pittsburgh 22, Pa.)

25–29. Atmospheric Condensation Nuclei, 2nd intern. symp., Basel and Locarno, Switzerland. (M. Bider, Astronomical Meteorological Station, Basel, Switzerland.)

25–29. Automatic Controls, international conf., Univ. of Heidelberg, Germany. (R. Oldenburger, Woodward Governor Co., Rockford, Ill.)

26–28. The Direction of Research Organizations, intern. symp. Teddington, England. (National Physical Laboratory, Teddington, Middlesex, England.)

26–28. Mississippi Valley Medical Soc., annual, Chicago, Ill. (H. Swanberg, 510 Maine St., Quincy, Ill.)

26–29. European Cong. of Allergology, 3rd, Florence, Italy. (U. Serafini, Instituto di Patologia Medica, Viale Morgagni, Florence.)

27. Atomic Energy in Economic Development, Washington, D.C. (C. Allardice, International Bank for Reconstruction and Development, 1818 H St., NW, Washington 25.)

27–30. Alaskan Science Conf., 7th annual, Juneau. (H. C. Baltzo, U.S. Fish and Wildlife Service, Juneau.)

28–29. American Medical Writers' As-

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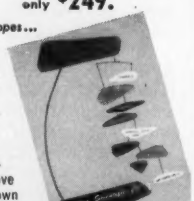

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soc., annual, Chicago, Ill. (H. Swanberg, 510 Maine St., Quincy, Ill.)

28–29. Chemistry of Lignin, Polysaccharides and Related Substances, symp., Tucson, Ariz. (Dept. of Chemistry, Univ. of Arizona, Tucson.)

28–29. International Professional Union of Gynecologists and Obstetricians, 1st cong., Madrid, Spain. (J. Courtois, St. Germain-en-Laye, Seine-et-Oise, France.)

30. American College of Dentists, annual, Atlantic City, N.J. (O. W. Brandhorst, 4221 Lindell Blvd., St. Louis, Mo.)

30–4. Electrochemical Soc., Cleveland, Ohio. (H. B. Linford, 216 W. 102 St., New York 25.)

October

1–2. American Soc. of Photogrammetry, semiannual, Denver, Colo. (C. E. Palmer, ASP, 1515 Massachusetts Ave., NW, Washington 5.)

1–3. Institute of Radio Engineers, Canadian convention, Toronto, Canada. (G. Sinclair, Electrical Engineering Dept., Univ. of Toronto, Toronto.)

1–3. National Electronics Conf., 12th annual, Chicago, Ill. (NEC, 84 E. Randolph St., Chicago 1.)

1–4. American Dental Assoc., annual, Atlantic City, N.J. (H. Hillenbrand, ADA, 222 E. Superior St., Chicago 11, Ill.)

1–4. Semiconductor Symposium, Cleveland, Ohio. (M. F. Lamorte, Semiconductor Dept., Westinghouse Electric Corp., Youngwood, Pa.)

1–5. American Inst. of Electrical Engineers, fall general, Chicago, Ill. (N. S. Hibshman, AIEE, 33 W. 39 St., New York 18.)

1–5. International Cong. on Medical Records, 2nd, Washington, D.C. (Miss G. L. Perkins, American Assoc. of Medical Record Librarians, 510 N. Dearborn St., Chicago 10, Ill.)

1–10. Weights and Measures, international committee, Paris, France. (C. Volet, International Bureau of Weights and Measures, Pavillon de Breteuil, Sevres (Seine-et-Oise), France.)

2–14. Engineers Cong., 2nd international Federation of National Associations of Engineers, Zurich, Switzerland. (Federation Internationale d'Associations Nationales d'Ingenieurs, 19, rue Blanche, Paris 9e, France.)

8. Science and Human Welfare, international conf., American Inst. of Geonomy and Natural Resources, Washington, D.C. (R. M. Field, AIGNR, South Duxbury, Mass.)

8–10. National Clay Conf., 5th, Urbana, Ill. (R. E. Grim, Univ. of Illinois, Urbana.)

8–12. American College of Surgeons, 42nd annual clinical cong., San Francisco, Calif. (ACS, 40 E. Erie St., Chicago 11, Ill.)

8–12. International Decennial Review Conf. on Tissue Culture, Woodstock, Vt. (P. R. White, Jackson Memorial Laboratory, Bar Harbor, Me.)

8–12. National Metal Cong., 38th annual, Cleveland, Ohio. (American Inst. of Mining, Metallurgical and Petroleum Engineers, 29 W. 39 St., New York 18, N.Y.)

8–12. Pan-American Federation of Engineering Societies, 4th convention, Mexico, D.F., Mexico. (S. E. Reimel, Engineers Joint Council, 29 W. 39 St., New York 18.)

8–13. International Cancer Cytology Cong., Chicago, Ill. (A. H. Dearing, College of American Pathologists, Prudential Plaza, Chicago 1.)

9–10. Air Research and Development Command Science Symposium (classified), 4th annual, Boston, Mass. (Headquarters, ARDC, U.S. Air Force, P.O. Box 1395, Baltimore 3, Md.)

9–12. American Dietetic Assoc., 39th annual, Milwaukee, Wis. (Mrs. T. Pollen, ADA, 620 N. Michigan Ave., Chicago 11, Ill.)

9–15. World Medical Assoc., 10th general assembly, Havana, Cuba. (L. H. Bauer, WMA, 345 E. 46 St., New York, N.Y.)

10–12. Indiana Acad. of Science, Bloomington. (W. A. Daily, Eli Lilly Research Laboratories, Indianapolis 6, Ind.)

10–18. Arid Zone Climatology with Special Reference to Microclimatology, international symposium, Melbourne and Canberra, Australia. (UNESCO, 19 Avenue Kléber, Paris 16e, France.)

11–12. International Scientific Radio Union, U.S. National Committee, Berkeley, Calif. (J. P. Hagen, 2101 Constitution Ave., NW, Washington 25.)

14–17. Society of American Foresters, Memphis, Tenn. (H. Clepper, SAF, 17th and Pennsylvania Ave., NW, Washington 6.)

14–19. American Acad. of Ophthalmology and Otolaryngology, annual, Chicago, Ill. (W. L. Benedict, 100 First Ave. Bldg., Rochester, Minn.)

15–17. Assoc. of Official Agricultural Chemists, annual, Washington, D.C. (W. Horwitz, Box 540, Benjamin Franklin Station, Washington 4.)

15–17. Soil Conservation Soc. of America, Tulsa, Okla. (H. W. Pritchard, SCSA, 1016 Paramount Bldg., Des Moines, Iowa.)

15–18. American Veterinary Medical Assoc., annual, San Antonio, Tex. (J. G. Hardenbaugh, AVMA, 600 S. Michigan Ave., Chicago 5, Ill.)

15–19. American Soc. of Civil Engineers, annual, Pittsburgh, Pa. (W. H. Wisely, ASCE, 33 W. 39 St., New York 18.)

15–26. New York Acad. of Medicine, annual graduate fortnight, New York, N.Y. (Secretary, Graduate Fortnight, NYAM, 2 E. 103 St., New York 29.)

16–17. National Acad. of Economics and Political Science, Washington, D.C. (D. P. Ray, George Washington Univ., Washington 6.)

16–18. Conference on Magnetism and Magnetic Materials, Boston, Mass. (T. O. Paine, Measurements Laboratory, General Electric Co., West Lynn, Mass.)

17–19. Symposium on Antibiotics, 4th annual, Washington, D.C. (H. Welch, Div. of Antibiotics, Food and Drug Administration, U.S. Dept. of Health, Education, and Welfare, Washington 25.)

18–19. Institute of Management Sciences, 3rd annual, Los Angeles, Calif. (C. M. Kelly, Litton Industries, Inc., 336 N. Foothill Rd., Beverly Hills, Calif.)

(See issue of 17 August for comprehensive list)

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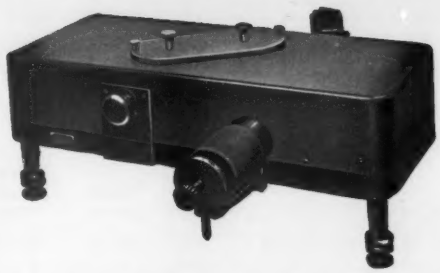

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Equipment News

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■ SERUM-AGAR MEASURING AID, for photometric quantitation of serum-agar columns, indicates density and distance of leading edges, trailing edges, and zone widths of diffusing precipitin systems. (Analytical Instruments, Dept. S13)

■ PIEZOELECTRIC PRESSURE TRANSDUCER employs sensitive elements of the lead zirconate formulations and provides free-field pressure-time traces for sound or shock waves. It covers a range of up to 1000 lb/in.^{2} and flat frequency response (±2 db) from 1 to 80,000 cy/sec. Capacitance of the unit is 0.0025 μf, and its d-c resistance is maintained above 500 Mohm. The sensitivity of the instrument is stable over a temperature range of from −40° to 100°C. (Atlantic Research Corp., Dept. S20)

■ METABOLISM CAGE permits laboratory investigation of the excretion patterns of small animals that have been injected with C^{14}-labeled compounds. Toluene is used as a urine preservative in the collecting flask and serves as an indicator for the system. The air from the chamber is bubbled through an alkaline absorption column, from which the CO_2 may be recovered for radioassay. The central column is removable through a rubber sleeve for replacement, and a filling funnel and side arm makes possible the replacement of the absorbing solution, which is removed at the bottom of the tower. A trap in the floor of a feeder prevents the animals from pulling small crumbs into the cage. Temperature may be controlled with fans and moist towels under difficult weather conditions. A bank of three or four cages can utilize a single manostat set at about 10 mm-Hg below 1 atm. (Birsch Scientific Co., Dept. S16)

■ ISOTOPE INDEX lists the sources of known commercially available isotopes. Included are stable and radioactive isotopes and a large number of compounds labeled C^{14}, I^{134}, P^{32}, S^{35}, deuterium, and other isotopes. Chemical name or formula, specific activity, interfering activities, half-life, and principal radiation are given for each of more than 2000 items. The 64-page publication also includes sections on available calibration samples and radiographic and therapeutic sources. (Scientific Equipment Corp., Dept. S21)

■ PYROMETER SYSTEM for measurements up to 1000°C employs a first-surfaced spherical mirror to collect energy, which is interrupted at 180 cy/sec and focused on a thermistor-bolometer detector. The detector is bridge-connected to a compensating thermistor; its amplified and rectified output is proportional to the difference in radiant energy between the radiation tested and that of an internal source. Focusing is accomplished by moving the detector-preamplifier assembly. The field of view is 1°, and the over-all response time is 25 msec. (Servo Corp. of America, Dept. S29)

■ LOW-BACKGROUND DETECTOR measures low-energy beta radiations. Cosmic-ray and gamma-ray shielding are incorporated. A halogen-filled, flat Geiger-Müller counter with a 1-in. diameter mica window is incorporated within a sealed Lucite housing. The samples fit into a receptacle in the slide of this housing. A 2-in. lead shield cuts out all but high-energy gamma radiation. The voltage plateau, with a slope of about 0.1 percent, covers about 100 v. The over-all efficiency with a thin source of Y^{90} is 24 percent. Sensitivities at which ±10-percent accuracy is attainable are 1.2, 0.7, and 0.5 count/min for counting times of 6, 12, and 24 hours. (Isotopes, Inc., Dept. S31)

Report to Members on Sale of AAAS Symposium Volumes

Of the 42 symposium volumes published by the Association, 15 remain available. Available titles are listed with prices—retail and special prepaid member prices—the number sold since publication, and the number sold during the year July 1955 through June 1956.

	Year published	Retail price	Members' prepaid price	Number of copies sold	Number sold July 1955-June 1956
Psychopharmacology	1956	$3.50	$3.00	2415	2415
The Luminescence of Biological Systems	1955	7.00	6.00	715	589
Advances in Experimental Caries Research	1955	6.75	5.75	575	432
Antimetabolites and Cancer	1955	5.75	5.00	1335	923
Fluoridation as a Public Health Measure	1954	4.50	4.00	1936	640
Sex in Microorganisms	1954	5.75	5.00	1137	330
Monomolecular Layers	1954	4.25	3.75	1042	210
The Present State of Physics	1954	6.75	5.75	1209	213
Astronomical Photoelectric Photometry	1953	3.75	3.25	822	103
Soviet Science	1952	1.75	1.50	3369	310
Industrial Science—Present and Future	1952	2.00	2.00	1944	65
Centennial	1950	5.00	4.50	2341	40
The Rickettsial Diseases of Man	1948	6.25	5.25	1408	41
Approaches to Tumor Chemotherapy	1947	7.75	6.50	1849	43
Mammary Tumors in Mice	1945	3.50	3.00	1586	33

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Shipped to all points via Air Express
For further information write
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Hypophysectomized Rats

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Healthy — AKC Registered
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POSITIONS WANTED

Internist, Diplomate; scientific background, M.S.; 4 years, teaching and research; 4 years, director, research, pharmaceutical company. Medical Bureau (Burneice Larson, Director), Palmolive Building, Chicago. X

Microbiologist, Ph.D.; 17 years' university experience in bacteriology, biochemistry, and phytopathology. Desires challenging opportunity. Box 196, SCIENCE. 8/24; 9/7

Nurse, Ed.D.; 13 years' experience nursing service and education. Desires deanship or directorship university school of nursing; prefers new or developing program. Box 193, SCIENCE. 8/17, 24, 31

Vertebrate Zoologist, Ph.D., Cornell 1956. Teaching, research. Vertebrate zoology, zoology, and biology. Assistant in biology, 3 years; vertebrate zoology and mammalogy, 1 year; teacher, high-school biology, 2 years. Box 201, SCIENCE. 8/24

Virologist, M.S. Tissue culture, academic and industrial research experience. Publications. Desires academic or industrial position. Box 209, SCIENCE. 8/31

Virologist–Immunologist, Ph.D. Director of virus tissue culture laboratory, desires relocation in responsible industrial or academic position. Box 210, SCIENCE. X

Zoophysiologist; Ph.D., 4 years' teaching and research experience desires teaching/research position, preferably West. Have taught general zoology, biology, comparative physiology, human physiology, and anatomy courses. Research in fields of G.I. histochemistry and reptilian enzymology. Willing to work in allied fields. Write to Dr. Gordon Ballmer at 4570 Voltaire, San Diego 7, California. X

POSITIONS OPEN

Chemist, Research Assistant, male or female; biochemical experience, $4000. Box 208, SCIENCE. 8/31

Instructor or **Assistant-Professor,** Ph.D. to teach **Comparative Anatomy and Embryology** this fall in midwestern university in undergraduate and graduate programs. Ample time and facilities for research. Give full details of education, experience, and salary requirement. Box 207, SCIENCE. X

Ph.D. for a Postdoctoral Fellowship in the area of avian embryology and histochemistry. For particulars write to Chairman, Department of Poultry Science, State Collge of Washington, Pullman, Washington. 8/31

(a) Physiologist, preferably Ph.D., with clinical training in illumination, color, physiology and psychology of vision, qualified as a group leader for research on surgical lighting; unusual opportunity; $10,000–$12,000; East. **(b) Chemist** to supervise department of chemistry, well-established clinical laboratories; Ph.D. or M.S. trained medical biochemistry; salary open, minimum $8000; California. **(c) Pharmacologist,** Ph.D., to organize, equip, and formulate injectable formulae; executive post, large company with expansion program; Southwest. **(d) Microbiologist,** preferably physician; faculty post; duties include directing microbiological laboratory, teaching hospital. S8-4, Medical Bureau (Burneice Larson, Director), Palmolive Building, Chicago. X

POSITIONS OPEN

Pharmacologists—Ph.D.

Established Research Division of growing Pharmaceutical Company has immediate opportunities for pharmacologists with experience and training in:

1) CNS drug research. Work will involve general pharmacological screening and development of pharmacological testing methods.
2) Cardiovascular research. Work will involve design and supervision of screening procedures and development of basic research program.

Company has modern research facilities, complete employee benefit program and is located in rural area of central New York State. Forward résumés to Personnel Director, The Norwich Pharmacal Company, Norwich, New York.

POSITIONS REQUIRING DEGREES IN MEDICINE OR SCIENCE: (a) Pharmacologist; outstanding opportunity for M.D. trained in pharmacology and biochemistry to serve as Director of Research and Medical Relations; important midwestern concern, interested only in creative scientifically minded physician for long range expansion program; $17,500, excellent compensation plan. **(b) Bacteriologists, Microbiologists, Biochemists;** B.S. or M.S. for research appointments, microbial enzymes; to $5500; East. **(c) Chief Biochemist;** Ph.D. to head division, well-known research institute, much be able to consult, collaborate with physicists, microbiologists on biochemical aspects of problems; complete and modernly equipped laboratory facilities; eastern resort community. **(d) Chemist;** Ph.D. or M.S. to supervise chemistry department, private clinical laboratory operated by six board pathologists; $8000; California. **(e) Chemist;** establish and develop new division, 300-bed general hospital; to $6000; Southeast. Woodward Medical Personnel Bureau, 185 North Wabash, Chicago. X

Research Fellowship in Biochemistry, leading to master's degree, $250 per month for 10 months, starting 18 September 1956. B. B. Carter, Western Michigan College, Kalamazoo, Michigan. X

Research Microbiologist. Minimum of 6 years required in either an industrial or academic capacity. A good background in immunology and biochemistry required. Ph.D. preferred, but will consider M.S. Salary open. Inquire of Dr. Earl B. Gerheim, Sherman Laboratories, 5031 Grandy, Detroit 11, Michigan. 8/10, 17, 24, 31

UNIVERSITY OF ALBERTA
Faculty of Agriculture

The University of Alberta invites applications for the position of professor of horticulture, duties to commence as soon as possible, but preferably not later than 1 June 1957. Minimum salary $6500, plus cost of living bonus, at present about $300, plus summer supplement of $425. Normal yearly increment is $250.

Applicants should hold the Ph.D. or equivalent in horticulture. Duties include teaching of horticulture courses to graduate and undergraduate students, supervising graduate student programs, and supervising an extensive research program particularly in fruits and vegetables. New laboratories and greenhouses offer excellent facilities.

Applications, giving age and other personal information, academic qualifications and experience, and the names and addresss of three references, together with a recent photograph or snapshot, should be sent to The Dean, Faculty of Agriculture, University of Alberta, Edmonton, Alberta, Canada. X

VIRUS SCREENING

Junior Research Virologist: M.S. or B.S. with some studies or laboratory work in virology and inoculation of small animals. Work involves virus screening procedures using small animals and tissue culture techniques.

Résumés welcomed from those, interested in and qualified for above work, who desire permanent employment in entirely new, air-conditioned research building located in rural area of central New York State.

Contact Personnel Director, The Norwich Pharmacal Company, Norwich, New York.

APPLICATION FOR HOTEL RESERVATIONS

123rd AAAS MEETING

New York City, December 26-31, 1956

The list of hotels and their rates and the reservation coupon below are for your convenience in making your hotel room reservation in New York. Please send your application, *not* to any hotel directly, but to the AAAS Housing Bureau in New York and thereby avoid delay and confusion. (Members of the American Astronomical Society who wish reservations at uptown hotels should correspond directly with the Hayden Planetarium.) The experienced Housing Bureau will make assignments promptly; a confirmation will be sent you in two weeks or less. **As in any city, single-bedded rooms may become scarce; double rooms for single occupancy cost more; for a lower rate, share a twin-bedded room with a colleague.** Most hotels will place comfortable rollaway beds in rooms or suites at 2.50 or 3.00 per night. Mail your application *now* to secure your first choice of desired accommodations. All requests for reservations must give a definite date and estimated hour of arrival, and also probable date of departure.

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

Rates for Rooms with Bath*

All hotels have sessions in their public rooms. For a list of headquarters of each participating society and section, please see *Science*, July 20, or *The Scientific Monthly* for August.

Hotel	Single	Double Bed	Twin Bed	Suite
Governor Clinton	$7.00–11.00	$10.00–13.00	$11.00–17.00	$20.00–35.00
Martinique	5.00– 9.00	8.00–14.00	8.00–14.00	16.00–38.00
New Yorker	7.00–10.00	10.00–14.00	11.50–17.00	25.00 and up
Sheraton-McAlpin	6.75– 9.75	9.75–12.75	10.75–13.75	20.00 and up
Statler	8.00–12.00	11.00–15.00	11.50–18.00	31.00–33.00

* Subject to 5% New York City tax on hotel rooms.

---------- **THIS IS YOUR HOUSING RESERVATION COUPON** ----------

AAAS Housing Bureau
90 East 42nd Street
New York 17, N. Y.

Date of Application .....

Please reserve the following accommodations for the 123rd Meeting of the AAAS in New York City, Dec. 26–31, 1956:

TYPE OF ACCOMMODATION DESIRED

Single Room ..... Desired Rate ..... Maximum Rate .....

Double-Bedded Room ..... Desired Rate ..... Maximum Rate ..... Number in party .....

Twin-Bedded Room ..... Desired Rate ..... Maximum Rate .....

Suite ..... Desired Rate ..... Maximum Rate ..... Sharing this room will be:

(Attach list if this space is insufficient. The name and address of each person, including yourself, must be listed.)

.....

.....

First Choice Hotel ..... **Second Choice Hotel** ..... **Third Choice Hotel** .....

DATE OF ARRIVAL ..... DEPARTURE DATE .....
(These must be indicated—add approximate hour, a.m. or p.m.)

NAME .....
(Individual requesting reservation) (Please print or type)

ADDRESS .....
(Street) (City and Zone) (State)

Mail this now to the Housing Bureau. **Rooms will be assigned and confirmed in order of receipt of reservation.**

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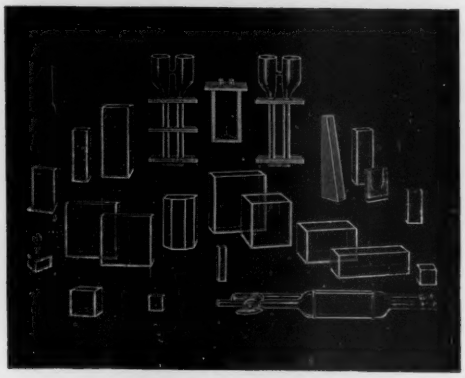

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Klett-Summerson Photoelectric Colorimeters—Colorimeters — Nephelometers — Fluorimeters—Bio-Colorimeters — Comparators — Glass Standards—Klett Reagents.

Klett Manufacturing Co.
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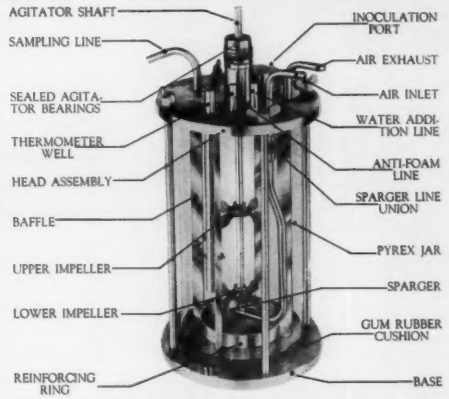
Model F-05

FOR STUDYING ALL KINDS OF METABOLIC PROCESSES IN SUBMERGED CULTURE



All stainless steel, with Pyrex Jar for full visibility. Entire assembly fits in autoclave for thorough sterilization. Non-freezing, non-bleeding agitator housing and seals. Five liter capacity (also available in 7.5 and 14 liters). Single orifice sparger centrally located under lower impeller.

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The ORIGINAL
Superspeed Angle Centrifuge

It takes pioneering "know-how" to produce operating quality that sets trade standards. That is why leading laboratories and researchers select the SERVALL SS-1, the *ORIGINAL* Superspeed Angle Centrifuge.

- CAPACITY: Precision-machined, anodized duralumin rotor accommodates *eight* 50-ml tubes at a 35° angle in separately numbered compartments. Accessory adapters available for 15-ml, 10-ml, and 5-ml tubes.
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Type SS-1A, same as SS-1 but with water-cooled bearing assembly for extra heavy duty.

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Ivan Sorvall, Inc.
P. O. BOX 230, NORWALK, CONNECTICUT

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BACTO-SENSITIVITY DISKS
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permit the determination of the sensitivity of microorganisms to ANTIBIOTICS, SULFONAMIDES and other CHEMOTHERAPEUTIC AGENTS including the anti-tubercular compounds by the Disk Plate Technique.

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Bulletin No. 146 and 152 giving complete details on use of Bacto-Sensitivity Disks and Bacto-Unidisks in microbial sensitivity testing available upon request, as well as Report Sheets for recording Microbial Sensitivities.

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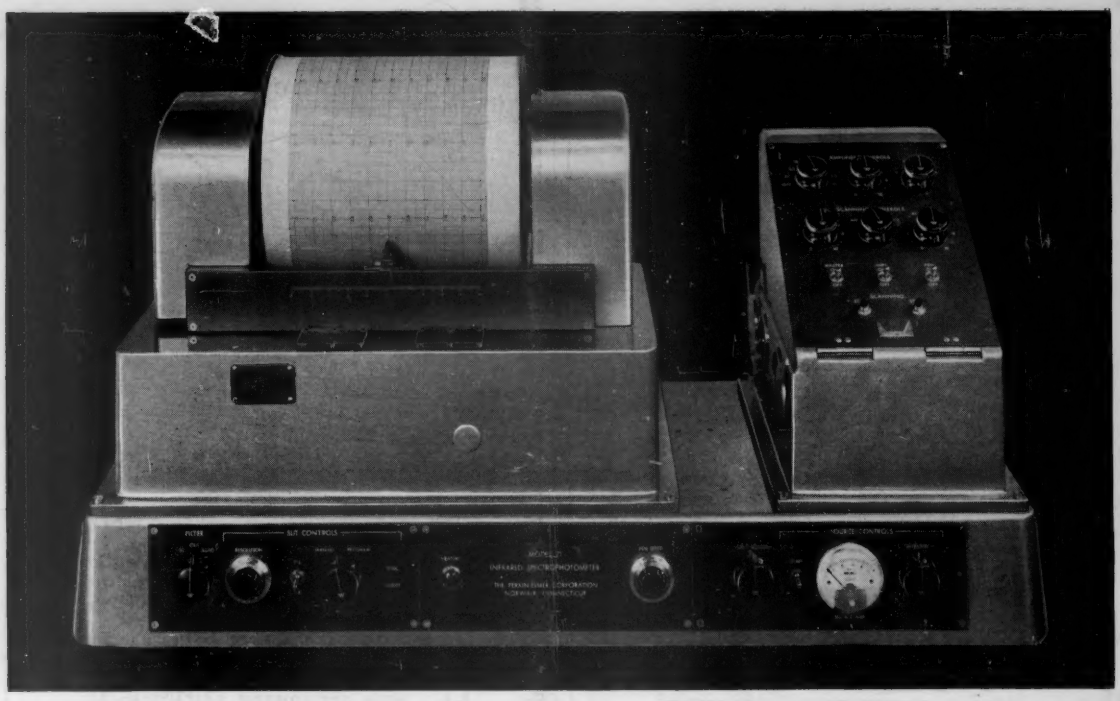

THE MODEL 21

The Standard Instrument for Infrared Analysis

The complete story of the dependability of the Model 21 double beam recording infrared spectrophotometer is being told by its users – in the laboratories of industry, the universities and private research organizations throughout the United States and abroad.

The Model 21 is the prime tool of the infrared field. Designed to provide both high quality survey spectra and precise quantitative data routinely, the Model 21's full capabilities are there when needed. A continuing program of instrument improvement and development insures the Model 21's position.

Accurate and precise, it offers complete flexibility in resolution, spectral presentation and recording speeds (with single switch automatic control, once operating conditions are chosen). A complete range of accessories extends its versatility: 5 different prism materials providing maximum resolution and range . . . 7 quick interchange assemblies recording linearly in wavelengths and wavenumber . . . gas cells from 5 cm to 10 M in path length . . . liquid cells, both macro and micro, high and low pressure, and with variable path length . . . polarizers, heatable cells, reflectance attachments for solid state studies, and so on.

The wavelength range of the Model 21 with standard optics is from 800 millimicrons to 15.5 microns *covering the near infrared and fundamental regions of the spectrum.* These two useful regions complement each other, and any Model 21 covers both.

The Model 21 is a product of Perkin-Elmer, world leader in infrared instrumentation, with its own sales and service offices throughout the United States.

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NORWALK, CONNECTICUT